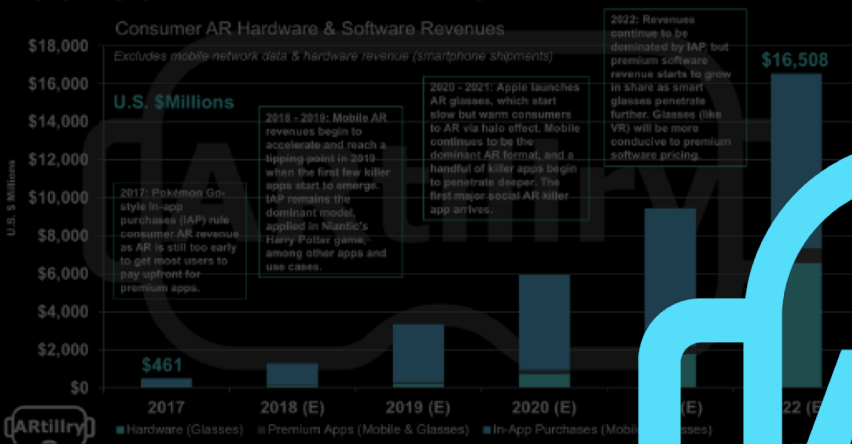
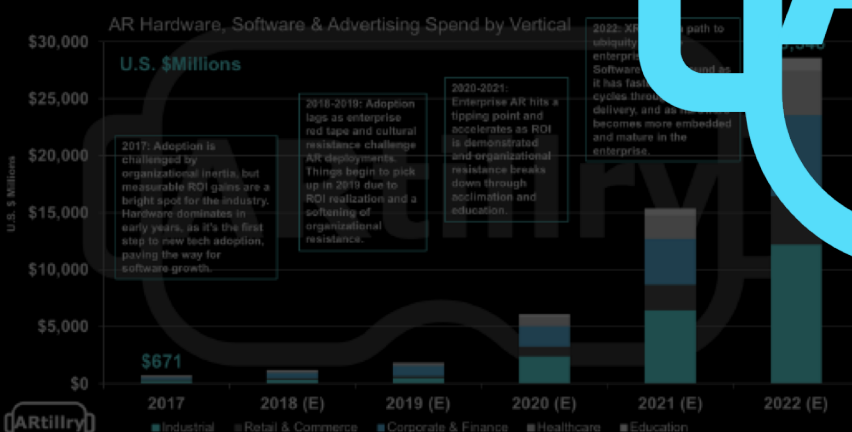


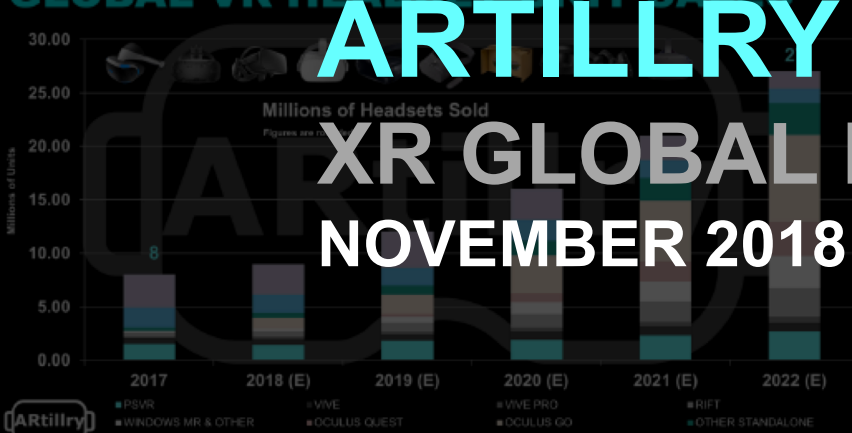
## CONSUMER AR DRILL DOWN



## ENTERPRISE AR DRILL DOWN



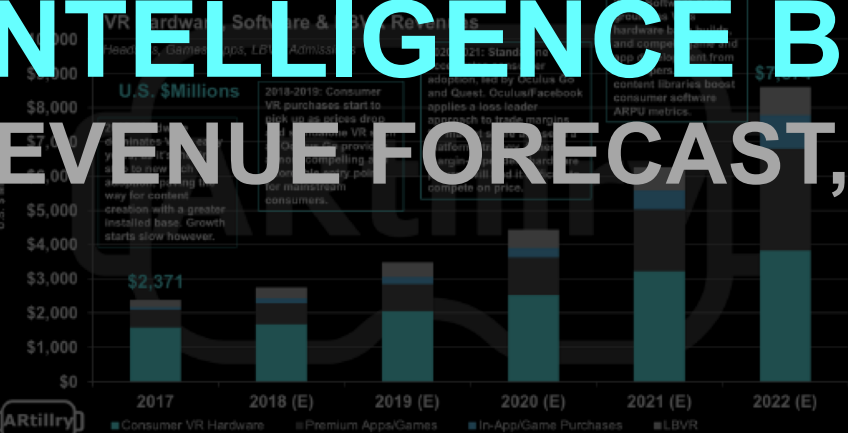
## GLOBAL VR HEADSET UNIT SALES



## GLOBAL VR HEADSET INSTALLED BASE



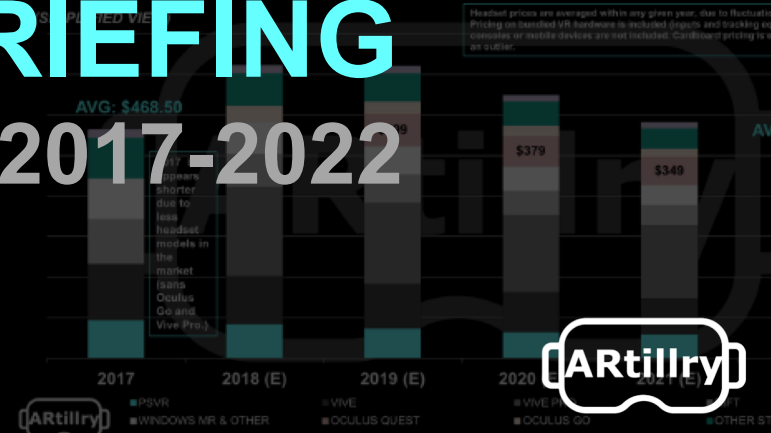
## CONSUMER VR DRILLDOWN



## GLOBAL VR HEADSET REVENUES



## GLOBAL VR HEADSET PRICING TRENDS



# ARTILLYRY INTELLIGENCE BRIEFING

## XR GLOBAL REVENUE FORECAST, 2017-2022

NOVEMBER 2018



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# EXECUTIVE SUMMARY



# INTRODUCTION

There's been volatile interest and investment in AR & VR over the past 24 months. But how big are these sectors, and how big will they get? *ARtillery Intelligence* has quantified the revenue opportunity in several AR & VR product areas. The result is our latest XR revenue forecast.

Applying market sizing and forecast experience from 15 years of analyst work (see methodology section), *ARtillery Intelligence* has devised a disciplined and independent revenue forecast for XR, segmented into sectors like AR, VR and enterprise and consumer sub-divisions of each.

The following pages provide market revenue projections within each product category, and bulleted insights all along the way. This is meant to qualify the revenue drivers and rationale behind the numbers. And we'll go deeper on specific data segments in future monthly reports.

Lastly, to characterize *ARtillery Intelligence*'s overall position on XR revenue growth, we maintain a cautiously-optimistic view. Growth and scale will come but likely slower than some industry proponents believe, due partly to the pace of adoption and other signals *ARtillery* tracks.

*ARtillery PRO* subscribers can spend time with the following pages, and contact us with questions or requests for deeper analysis using forms in the *ARtillery PRO* intelligence vault.



# WHAT'S COVERED IN FORECAST

The market sizing figures in this report include consumer and enterprise AR and VR segments. These are each subdivided by several variables, such as **hardware** and **software**, as well as revenue categories like **advertising** (social AR lenses) and **location-based VR** (admissions).

VR hardware includes headsets and bundled input or tracking devices, but does *not* include gaming consoles, smartphones and PCs required to run some headsets. Similarly with AR, smart glasses are included in revenue projections, but mobile devices (such iPhone sales) are not.

## INCLUDED

**AR & VR Hardware:** e.g. Headsets, smart glasses

**Bundled Hardware:** e.g. Input or tracking devices

**AR & VR Software:** e.g. Consumer (apps, in-app purchases), Enterprise (AR productivity software, retail installations)

**AR & VR Advertising:** e.g. Display (Snapchat Lenses), and Search (Google Lens) ad placements

**Location Based VR:** (e.g. admissions revenue)

## NOT INCLUDED\*

**PC or Gaming Consoles:** e.g. Playstation 4

**Smartphones:** e.g. iPhone to run ARkit apps

**Network Data:** e.g. Telco-delivered data usage for XR

**Professional Services:** e.g. Enterprise XR consulting

**Game/app creation:** e.g. Development costs, salaries

**Advertising creation:** Creative production costs

**VR Cameras:** e.g. 360 degree camera hardware

**eCommerce:** Value of goods bought through AR & VR interfaces (e.g. cost of a new couch bought or influenced through the IKEA Place app).



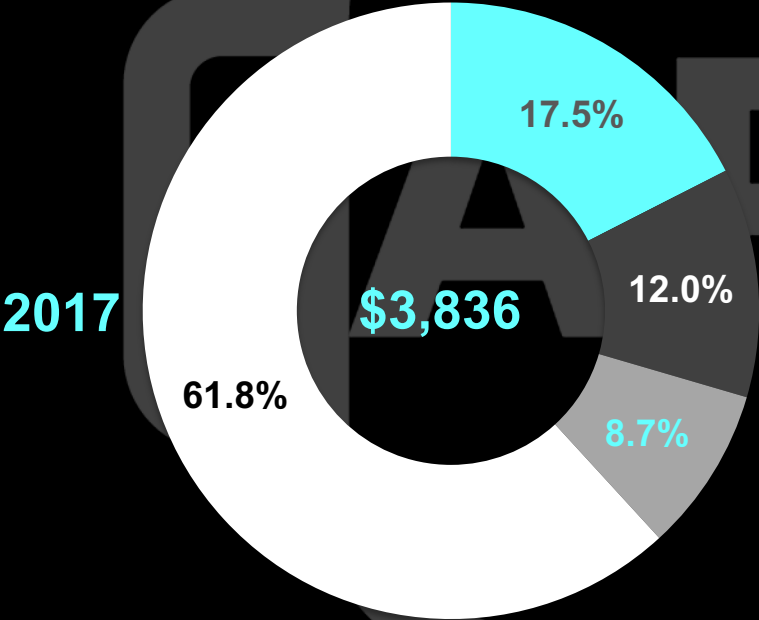
\*We will expand category inclusions in future forecasts

# KEY TAKEAWAYS

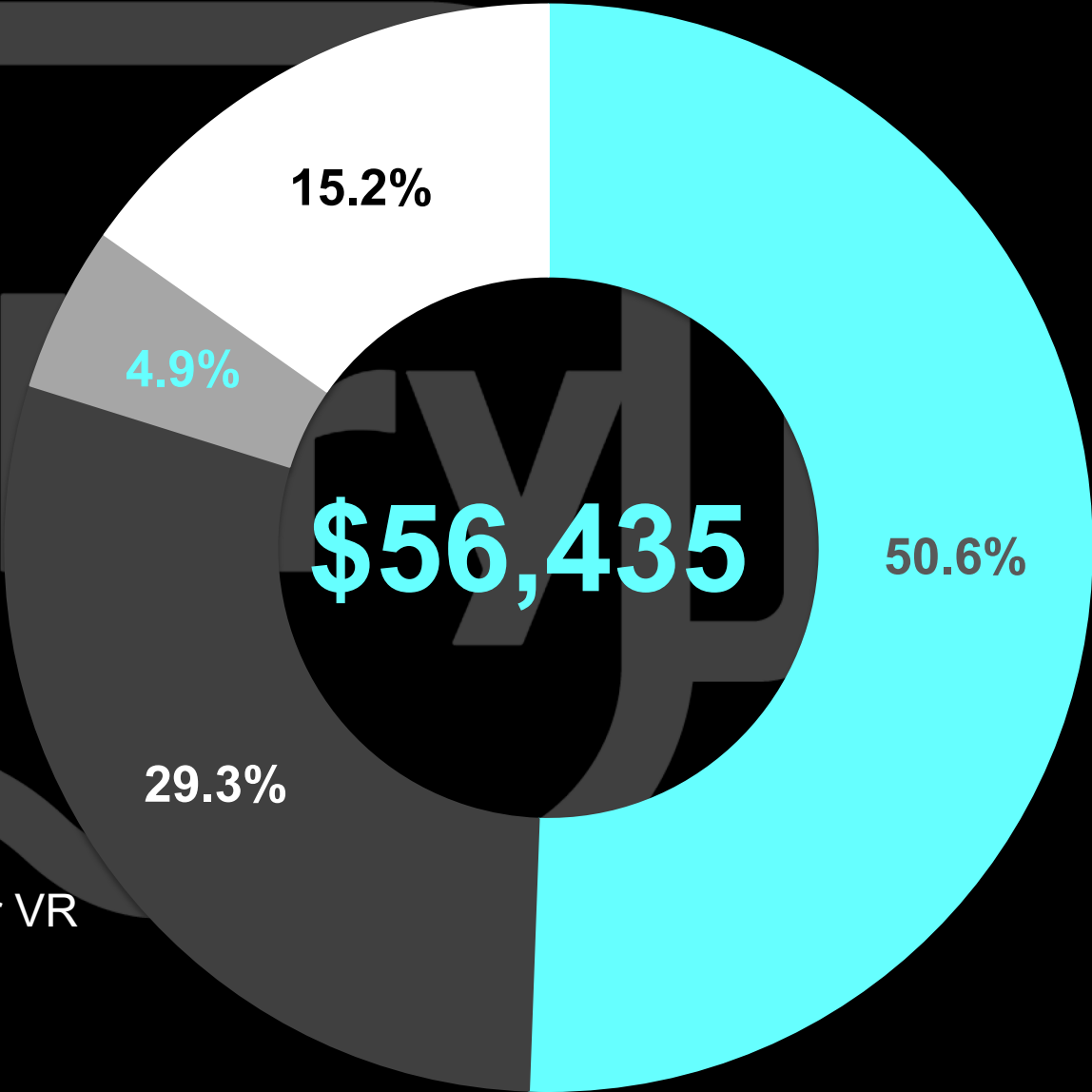


# GLOBAL XR REVENUE OVERVIEW

U.S. \$Millions



2022



■ Enterprise AR ■ Consumer AR ■ Enterprise VR ■ Consumer VR



# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Consumer AR** will grow from \$462 million in 2017 to \$16.5 billion in 2022, a 105 percent compound annual growth rate (CAGR). Near term revenues will be dominated by the mobile form factor. Revenues will also be software-centric during that time (mobile device sales aren't counted in this forecast) and will include premium apps and in-app purchases. The latter will dominate software revenues in the near term, due to consumer hesitance to pay upfront for AR apps, as well as the in-app revenue model validated by Pokémon Go. Niantic will find success in its Harry Potter-themed follow-up game to Pokémon Go, and its AR developer platform (AR as a Service) built on its architecture and game mechanics. These and other developing AR experiences will be built around in-app purchase models. A mobile AR killer app could emerge in 2019, likely built around a utility like Visual Search, or through viral growth of a native AR social/multiplayer app. Consumer AR revenues will begin to shift towards hardware starting in 2022 as smart glasses (possibly from Apple) finally reach tenable specs and standards for consumer markets. Software at that time will begin to shift to premium purchases (as opposed to in-app purchases) as it's a model conducive to dedicated AR hardware (similar to how apps/games are purchased in VR). Until then, development work in mobile AR apps will be a training ground for an eventual glasses-dominant era beyond 2022.



# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Enterprise AR** will grow from \$671 million in 2017 to \$28.5 billion in 2022, a 120 percent compound annual growth rate (CAGR). This makes it the largest XR sub-sector in 2022. Scale will result from wide applicability across enterprise verticals; and a form factor that supports all-day use and clear ROI (e.g. manufacturing efficiencies). Adoption is currently dampened by typical organizational inertia, enterprise risk aversion and sales cycles. ARtillery Intelligence believes these factors will continue to stunt enterprise AR growth but will be outweighed eventually by the momentum, support and ROI realizations that are currently building. A tipping point will come in 2020, after which adoption accelerates in a sort of enterprise herd mentality. This will follow a similar pattern, though on a smaller scale, as enterprise smartphone adoption over the past decade and is further supported by survey-validated enterprise AR pilot projects active today. Near-term Enterprise AR revenues will be hardware-dominant as it's the first step in enterprise tech adoption. Hardware growth creates an installed base for software, which will dominate enterprise AR in outer years. Enterprise hardware will also mature as it's established in the enterprise, with replacement cycles outpaced by software refresh rates, likely packaged and sold in a SaaS manner. AR advertising spend by enterprises is included in these figures and segmented in this report.

# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Consumer VR** will grow from \$2.4 billion in 2017 to \$8.6 billion in 2022, a 29 percent compound annual growth rate (CAGR). Like enterprise VR, it will be hardware-dominant in early years as its installed base is established. Over time, software (in this case, games and apps) will eclipse hardware revenues with a faster refresh cycle. A greater installed base of hardware will also incentivize VR content creators to invest in long-form content, resulting in more robust VR content libraries and greater software spending per user (ARPU). Premium apps will dominate software revenues but in-app purchases will also contribute, especially in gaming. Installed software and apps will also dominate, but slowly give way to web VR as its capability evolves. Price competition among VR headset manufacturers (e.g. Oculus, Sony, Samsung) will accelerate consumer adoption. Oculus Go, at a \$199 price point, hits a sweet spot for content availability, quality and affordability, and we project it to reach unit sales of 990 thousand this year. Oculus – with the advantage of Facebook-backing – has the flexibility to apply loss-leader pricing in order to trade margins for market share. That will give it a strong competitive position versus players that are dependent on hardware revenue (i.e. HTC, Samsung). Given a gift-able price point, the 2018 holiday quarter will be a “moment of truth” for Oculus Go. The untethered higher-end Oculus Quest will see similar pricing and content advantages when it launches in Q2 2019.

# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.









**Enterprise VR** will grow from \$332 million in 2017 to \$2.8 billion in 2022, a 53 percent compound annual growth rate (CAGR). Though strong in its own right, it will hold the smallest share of XR revenues among the sub-sectors measured in this forecast. VR will be stronger as a consumer play (see previous slide), while AR is stronger in the enterprise. These VR shortcomings (relatively speaking) in the enterprise stem from the medium's inherent isolation, which inhibits some job functions and share of time per working day. This is especially true in industrial functions where “heads up” awareness is inherent, and where AR will conversely shine. VR will add more value in corporate and finance settings, such as employee training and data visualization among others (vertical spending breakdown provided in this report). Like AR, VR's near-term enterprise revenue will be hardware-dominant as it's the first step to tech adoption. That installed base will pave the way for enterprise VR software revenues to grow and overtake enterprise VR hardware revenues by 2022. Unlike AR, which will have specialized hardware that's optimized for enterprise functions, VR will utilize common hardware (the same hardware used in consumer contexts). The availability, evolution and economics of that increasingly penetrated hardware will be an adoption accelerant, and an advantage for enterprise VR.



# GLOBAL XR REVENUES










# GLOBAL XR REVENUES

-  **Global AR & VR product revenues will grow from U.S. \$3.8 billion in 2017 to U.S. \$56.4 billion in 2022, a 71% compound annual growth rate (CAGR).**
-  **The largest share of revenue in 2017 was held by VR (driven by consumer markets) which will shift over time as AR (driven by enterprise markets) gains momentum and revenue dominance through 2022.**
  -  **VR comprises 71% of revenues in 2017 and 20% in 2022.**
  -  **AR comprises 29% of revenues in 2017 and 80% in 2022.**
-  **Within VR, consumer revenue eclipses enterprise by a factor of 3-1 in 2022.**
  -  **Standalone VR (e.g. Oculus Go) will accelerate consumer adoption.**
  -  **VR's form factor is aligned more with gaming and entertainment.**
  -  **VR's isolation inhibits industrial job functions, mobility and share of time per working day. It will however shine in corporate and finance contexts.\***



*\*See vertical spending analysis in this report's enterprise VR section.*

# GLOBAL XR REVENUES (CONT')

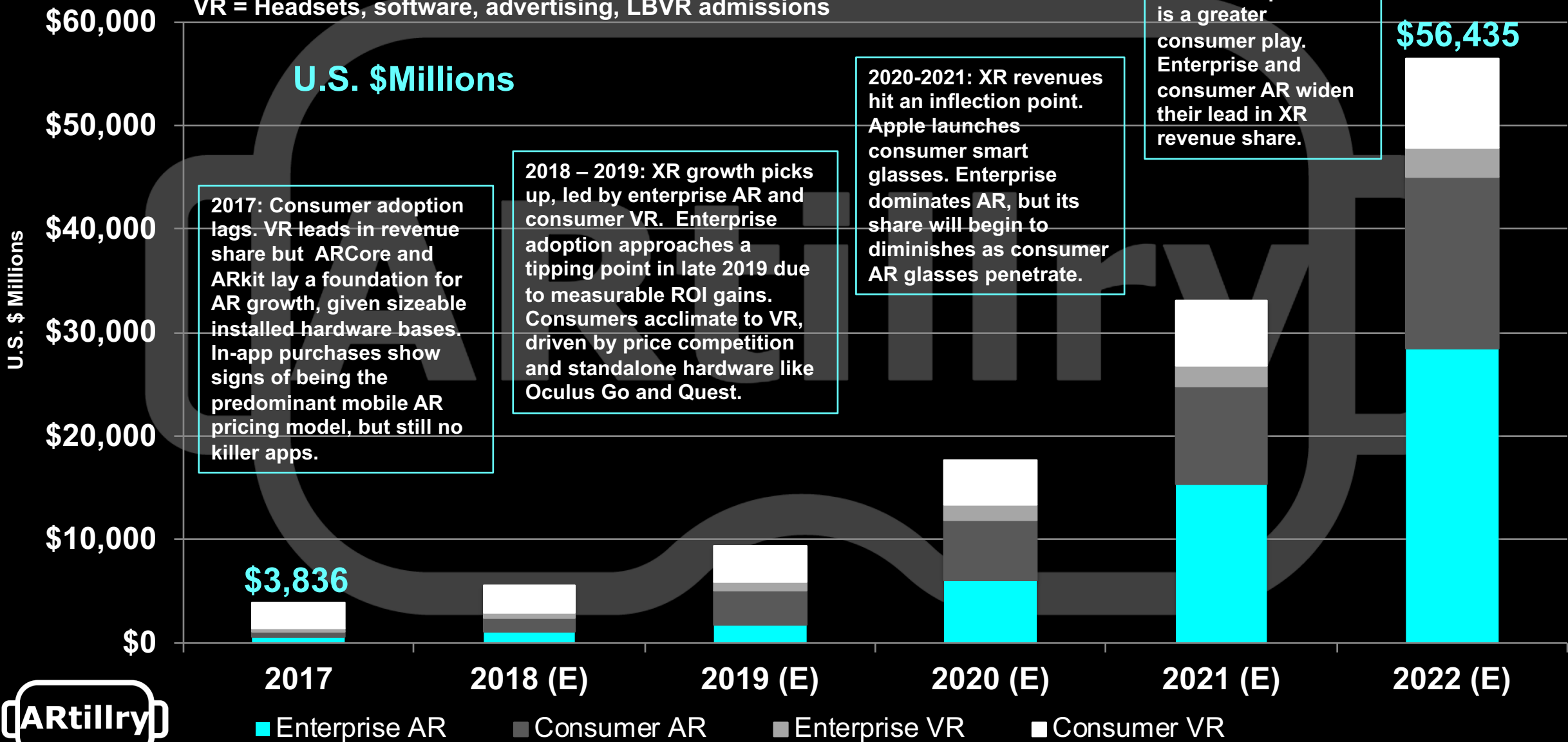
-  Within AR, the opposite is true: enterprise revenue outweighs consumer revenue by as much as 72% over the next five years.
  -  Head-worn AR's form factor is well-aligned with enterprise productivity such as manufacturing, assembly and medical procedures.
  -  Workplace productivity can grow as much as 99% according to Scope AR.
  -  Head-worn AR will find a home with consumers, however its specs and stylistic realities inhibit several consumer use cases in the near term.
-  Apple's potential 2021-2022 introduction of smart glasses will shift AR's momentum and revenue share towards consumer products.
  -  By 2022, enterprise AR's revenue dominance over consumer AR will decelerate as smart glasses (led by Apple) penetrate consumer markets.
  -  Until then, the mobile form factor will dominate consumer AR, with most revenue derived from software (mobile games, apps, in-app purchases) as opposed to hardware (smart glasses).



# GLOBAL XR REVENUE OVERVIEW

(SIMPLIFIED VIEW)

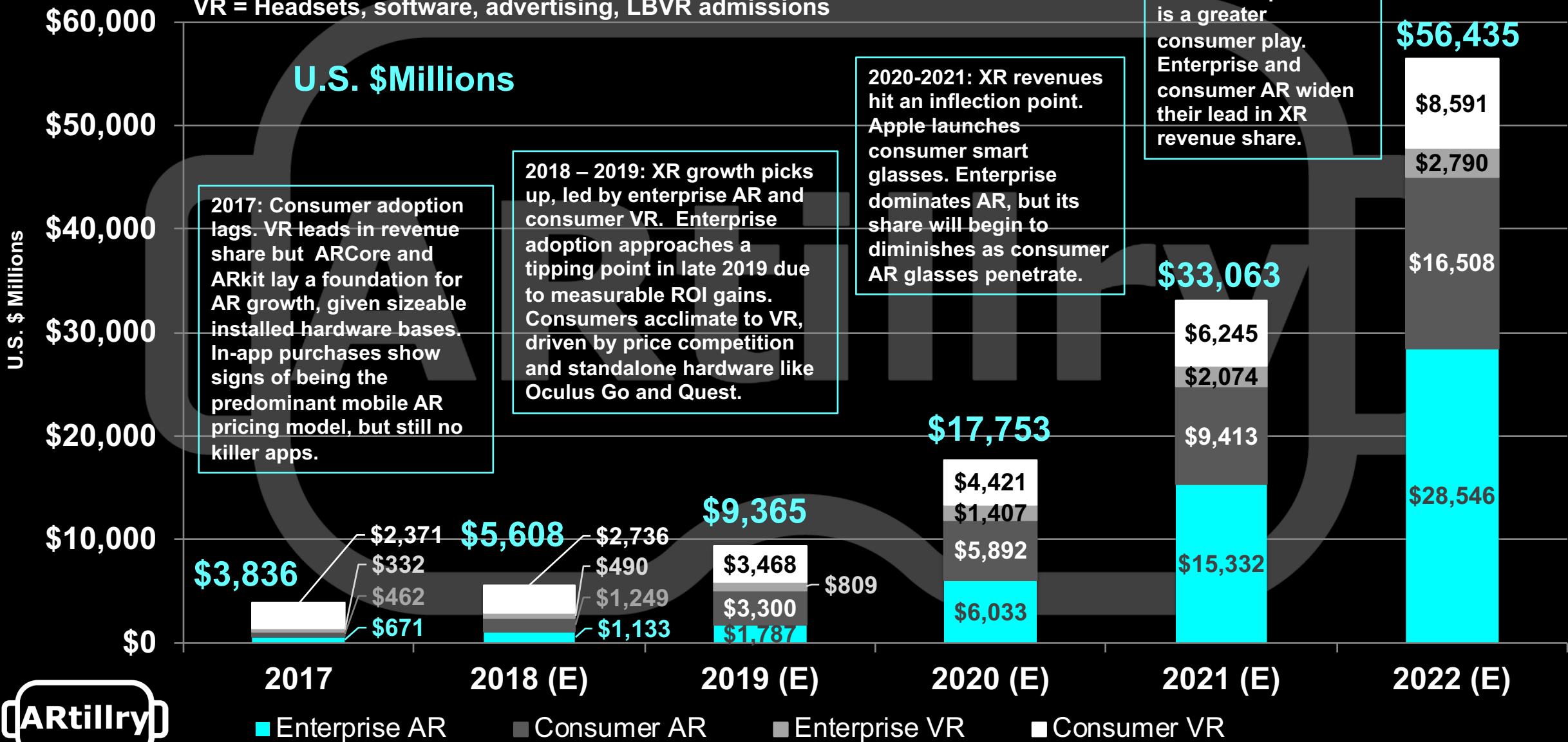
AR = Smart glasses, software (games, apps, etc.), advertising  
VR = Headsets, software, advertising, LBVR admissions



# GLOBAL XR REVENUE OVERVIEW

(DETAILED VIEW)

AR = Smart glasses, software (games, apps, etc.), advertising  
VR = Headsets, software, advertising, LBVR admissions



# **DRILLING DOWN ON AR**



# GLOBAL AR REVENUES

 **Global AR product revenues will grow from U.S. \$1.1 billion in 2017 to U.S. \$45.1 billion in 2022, a 109% compound annual growth rate (CAGR).**

 **Enterprise holds the largest share of AR revenue throughout the forecast period, culminating in a 63% share in 2022.**

 **Enterprise comprises 59% of AR revenues in 2017 and 63% in 2022.**

 **Consumer comprises 41% of AR revenues in 2017 and 37% in 2022.**

 **Consumer AR took an early lead in 2016 due to an anomaly: Pokémon Go. Revenue dipped in 2017 but will rebound in 2018 then inflect in 2020.**

 **Near term consumer AR growth is in software (e.g. in-app purchases), as mobile AR apps have a sizeable installed base of hardware to grow into.\***

 **Longer term, Apple's circa-2021 smart glasses will accelerate consumer AR and shift its composition – erstwhile software-dominant – to hardware.**



*\*See mobile AR hardware analysis and unit forecast in this report's AR hardware section.*

# GLOBAL AR REVENUE OVERVIEW

## AR Hardware, Software & Advertising Revenues

*Excludes mobile network data & hardware revenue (smartphone shipments)*

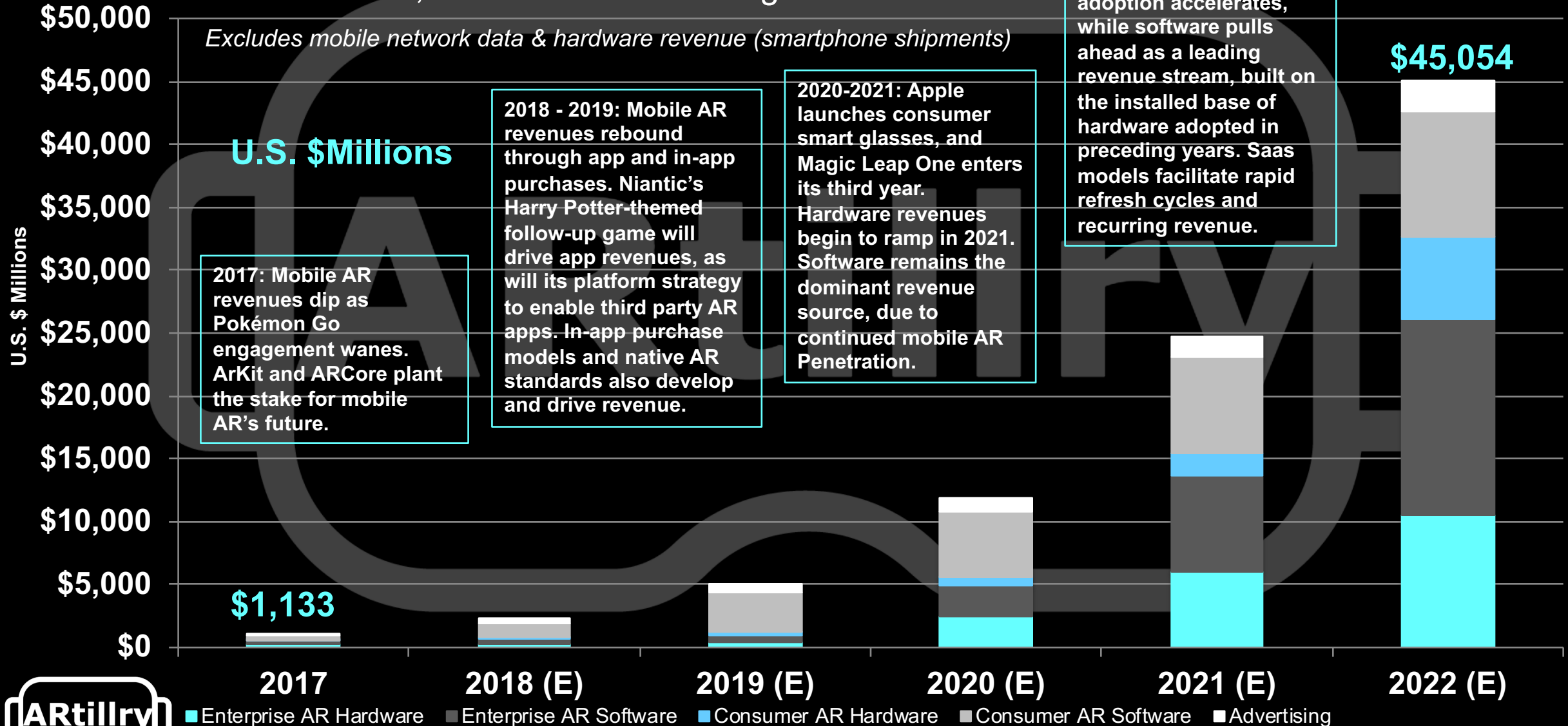
**U.S. \$Millions**

2017: Mobile AR revenues dip as Pokémon Go engagement wanes. ARKit and ARCore plant the stake for mobile AR's future.

2018 - 2019: Mobile AR revenues rebound through app and in-app purchases. Niantic's Harry Potter-themed follow-up game will drive app revenues, as will its platform strategy to enable third party AR apps. In-app purchase models and native AR standards also develop and drive revenue.

2020-2021: Apple launches consumer smart glasses, and Magic Leap One enters its third year. Hardware revenues begin to ramp in 2021. Software remains the dominant revenue source, due to continued mobile AR Penetration.

2022: Enterprise AR adoption accelerates, while software pulls ahead as a leading revenue stream, built on the installed base of hardware adopted in preceding years. SaaS models facilitate rapid refresh cycles and recurring revenue.



# GLOBAL AR REVENUE OVERVIEW

(DETAILED VIEW)

## AR Hardware, Software & Advertising Revenues

Excludes mobile network data & hardware revenue (smartphone shipments)

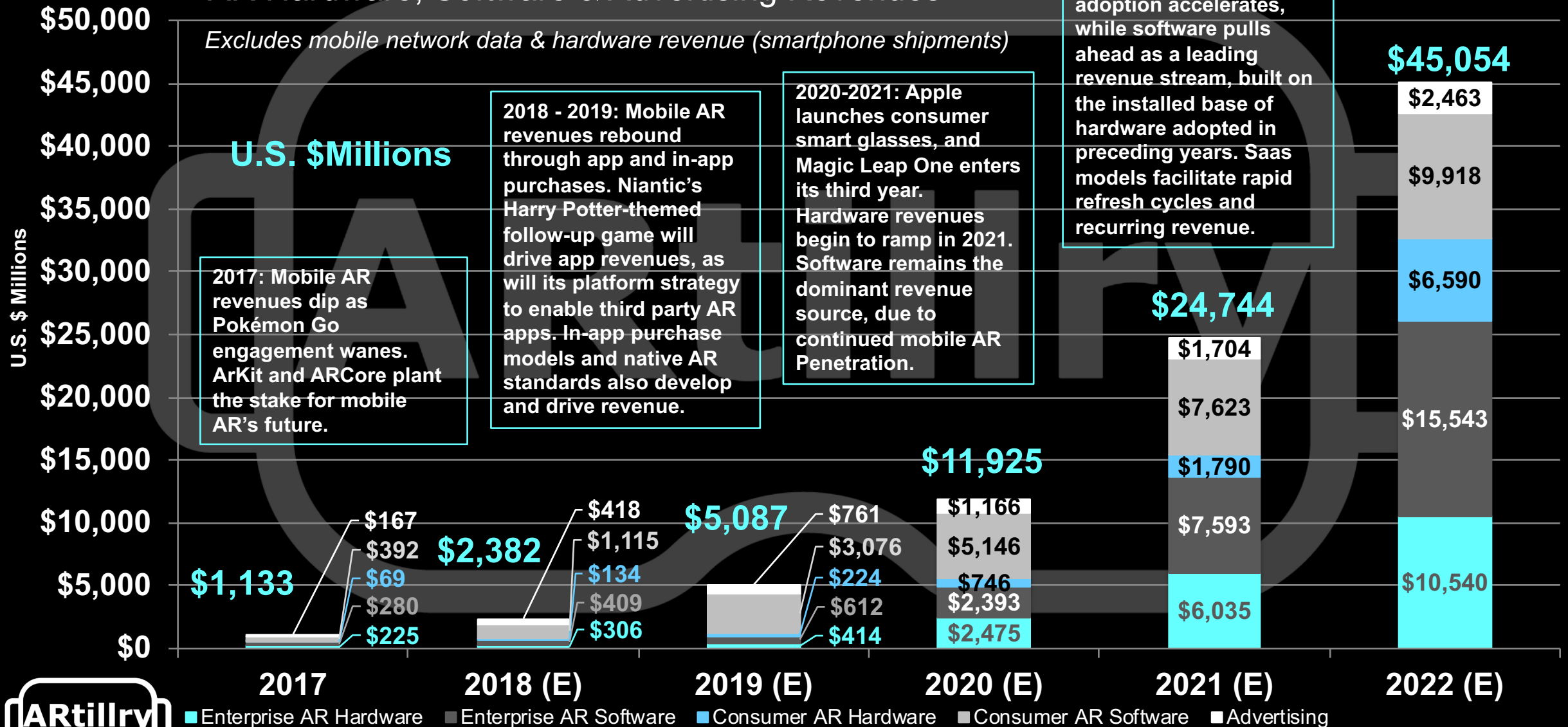
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# **COUNSUMER AR DRILL DOWN**



# CONSUMER AR REVENUES

-  **Near-term consumer AR revenues will be ruled by the mobile form factor.**
-  **Mobile AR revenues are in turn dominated by software.**
  -  **Mobile AR hardware (smartphone sales) aren't counted in this forecast, as it's a ubiquitous consumer device on which AR's function is secondary.**
  -  **Mobile AR software revenue includes premium app and in-app purchases.**
-  **In-app purchases (IAP) will dominate near-term mobile AR revenue – a vestige of the existing mobile app economy and its consumer acclimation.**
  -  **IAP has been further validated through its revenue generation for Pokémon Go, which will be replicated in several AR games and use cases.**
  -  **At mobile AR's early stages of consumer adoption, users aren't ready to commit to upfront (premium) app purchases, but are comfortable with IAP.\***
  -  **Premium app revenues will grow as a corollary to smart glasses, circa 2021, as that's how software will be bought for AR headsets (similar to VR).**



*\*Validated in ARtillery original survey research. See ARtillery Intelligence Briefing: [Mobile AR Usage & Consumer Attitudes](#)*

© ARtillery Intelligence, 2018

# CONSUMER AR DRILL DOWN

## Consumer AR Hardware & Software Revenues

*Excludes mobile network data & hardware revenue (smartphone shipments)*

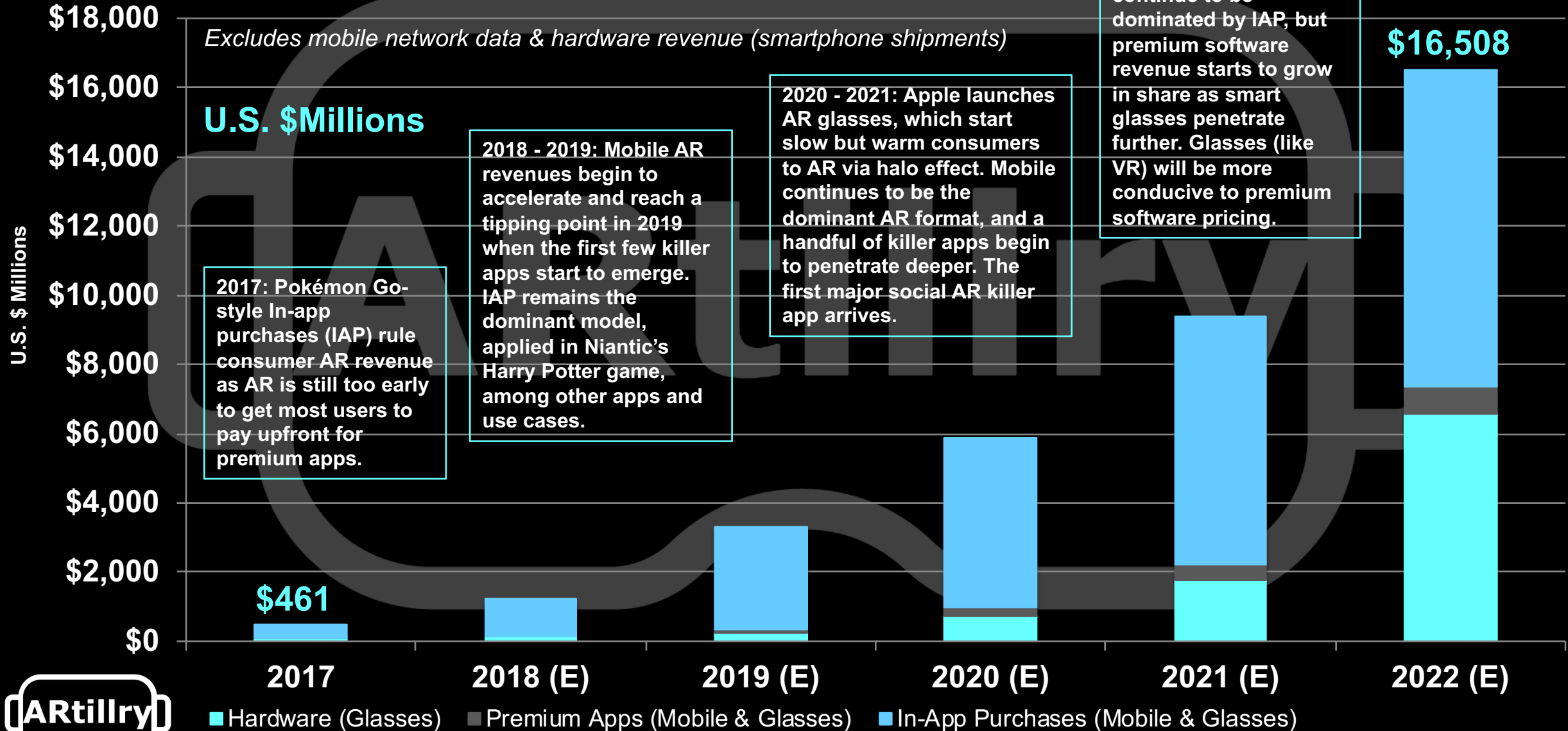
**U.S. \$Millions**

2017: Pokémon Go-style In-app purchases (IAP) rule consumer AR revenue as AR is still too early to get most users to pay upfront for premium apps.

2018 - 2019: Mobile AR revenues begin to accelerate and reach a tipping point in 2019 when the first few killer apps start to emerge. IAP remains the dominant model, applied in Niantic's Harry Potter game, among other apps and use cases.

2020 - 2021: Apple launches AR glasses, which start slow but warm consumers to AR via halo effect. Mobile continues to be the dominant AR format, and a handful of killer apps begin to penetrate deeper. The first major social AR killer app arrives.

2022: Revenues continue to be dominated by IAP, but premium software revenue starts to grow in share as smart glasses penetrate further. Glasses (like VR) will be more conducive to premium software pricing.



# CONSUMER AR DRILL DOWN

(DETAILED VIEW)

## Consumer AR Hardware & Software Revenues

Excludes mobile network data & hardware revenue (smartphone shipments)

U.S. \$Millions

2017: Pokémon Go-style In-app purchases (IAP) rule consumer AR revenue as AR is still too early to get most users to pay upfront for premium apps.

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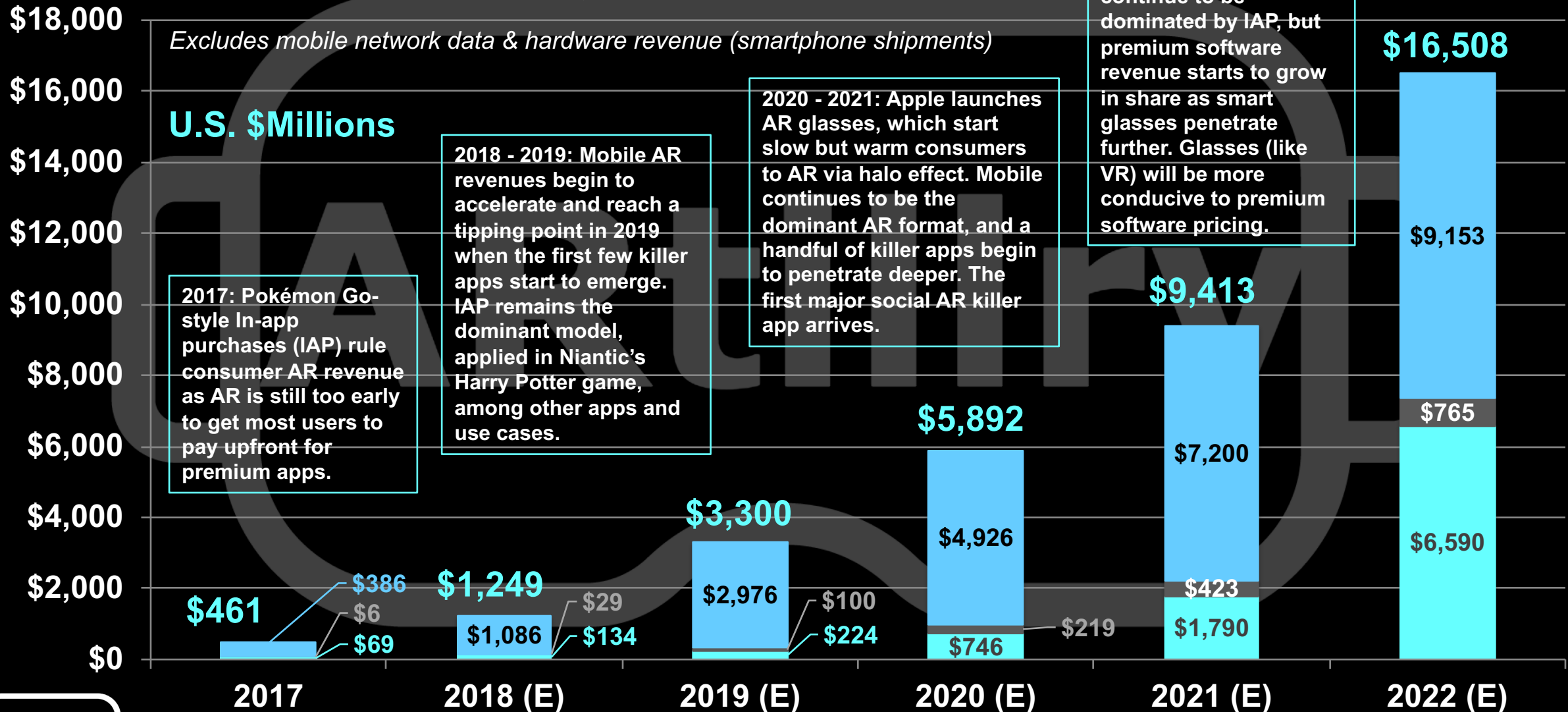
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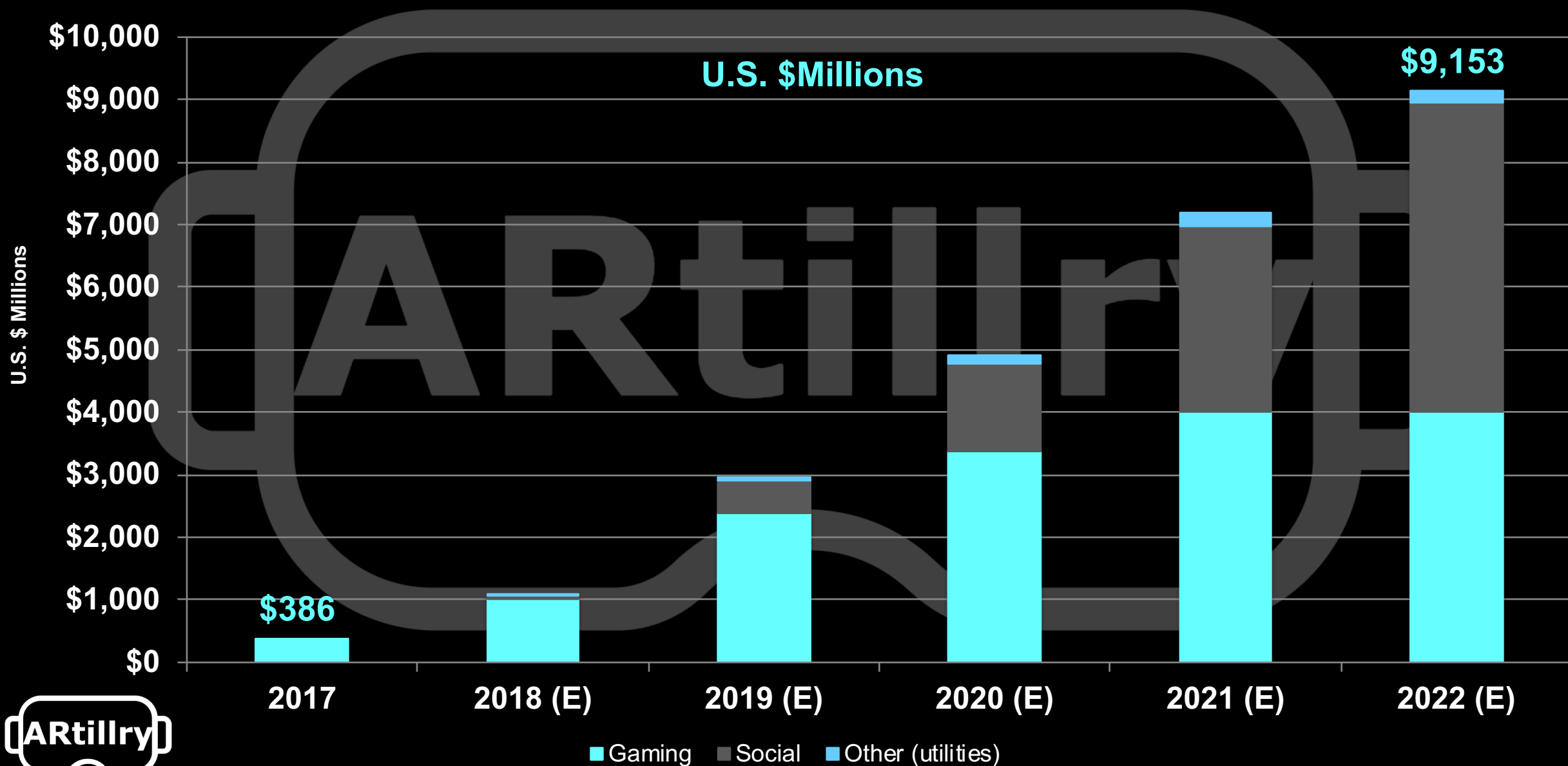
U.S. \$ Millions



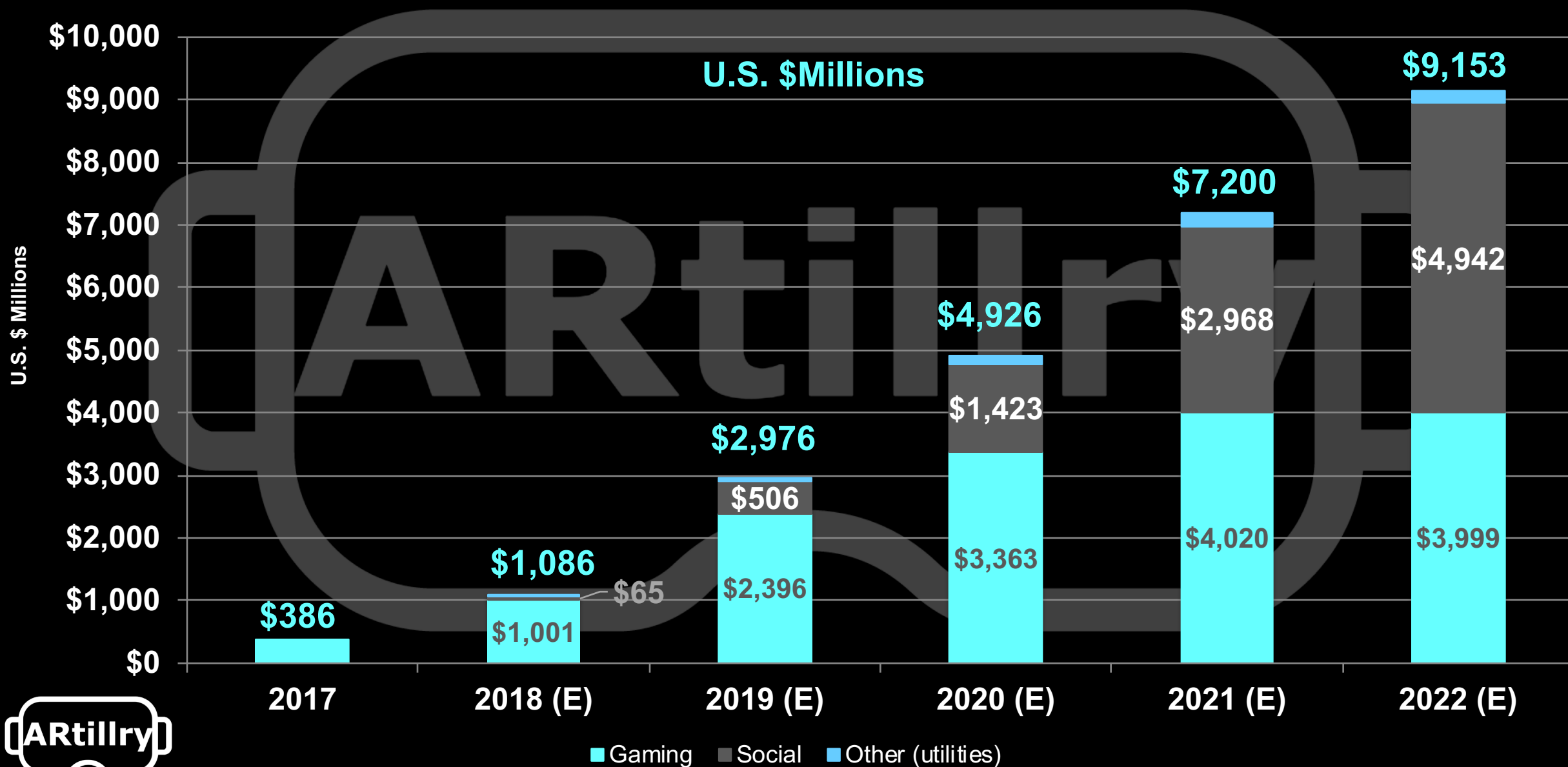
■ Hardware (Glasses) ■ Premium Apps (Mobile & Glasses) ■ In-App Purchases (Mobile & Glasses)



# MOBILE AR IAP SEGMENTATION



# MOBILE AR IAP SEGMENTATION












# ENTERPRISE AR DRILL DOWN



# ENTERPRISE AR REVENUES

-  Unlike Consumer AR, Enterprise AR revenues will be hardware-dominant in the near term (smart glasses).
-  As is often the case with enterprise technologies, hardware comes first and establishes an installed base that paves the way for software revenue.
  -  Over time, software revenue share grows through recurring purchases (e.g. SaaS enterprise software) that outpace hardware replacement cycles.
-  Unlike VR, which comprises the same headsets for consumer and enterprise buyers (e.g. HTC Vive), AR hardware is mostly designed for one or the other.
  -  This is due to stylistic nuances required in consumer markets.
  -  Apple's circa-2021 smart glasses will be consumer-targeted (size, weight, style, etc.) but could be optimized in some ways for enterprise contexts.
  -  Enterprise and consumer AR glasses design could eventually converge.



# ENTERPRISE AR REVENUES (cont'd)

 AR advertising spend is included in our enterprise AR revenue figures, and today primarily consists of brand marketing with social AR lenses.

 Snapchat has sold the most sponsored lenses, but Facebook's camera effects platform will quickly gain share with ad inventory on the News Feed, Instagram, Messenger and other Facebook properties.

 Though it won't materialize into significant ad dollars for a few years, search-based advertising through Google visual search (e.g. Google Lens) could become a valuable "high consumer intent" form of AR ads.\*

 Overall we're bearish on AR advertising as a considerable revenue source for the near term, given that it's inventory constrained due to low consumer usage (in advertising terms), and AR's short session lengths.

 VR suffers from similar ad inventory constraints, due to its low usage levels (covered separately in VR section), and brand advertisers' need for greater reach.



# ENTERPRISE AR DRILL DOWN

## Enterprise AR Hardware, Software & Advertising Spend

*Excludes mobile network data & hardware revenue (smartphone shipments)*

**U.S. \$Millions**

**2017:** Adoption is challenged by organizational inertia, but measurable ROI gains are a bright spot for the industry. Hardware dominates in early years, as it's the first step to new tech adoption, paving the way for software growth.

**2018-2019:** Adoption lags as enterprise red tape and cultural resistance challenge AR deployments. Things begin to pick up in 2019 due to ROI realization and a softening of organizational resistance.

**2020-2021:** Enterprise AR hits a tipping point and accelerates as ROI is demonstrated and organizational resistance breaks down through acclimation and education.

**2022:** XR starts a path to ubiquity in some enterprise fields. Software gains ground as it has faster refresh cycles through SaaS delivery, and as hardware becomes more embedded and mature in the enterprise.

**\$28,546**

U.S. \$ Millions

\$30,000  
\$25,000  
\$20,000  
\$15,000  
\$10,000  
\$5,000  
\$0

**2017**

**2018 (E)**

**2019 (E)**

**2020 (E)**

**2021 (E)**

**2022 (E)**

■ Hardware (Head Worn)

■ Software (Head Worn)

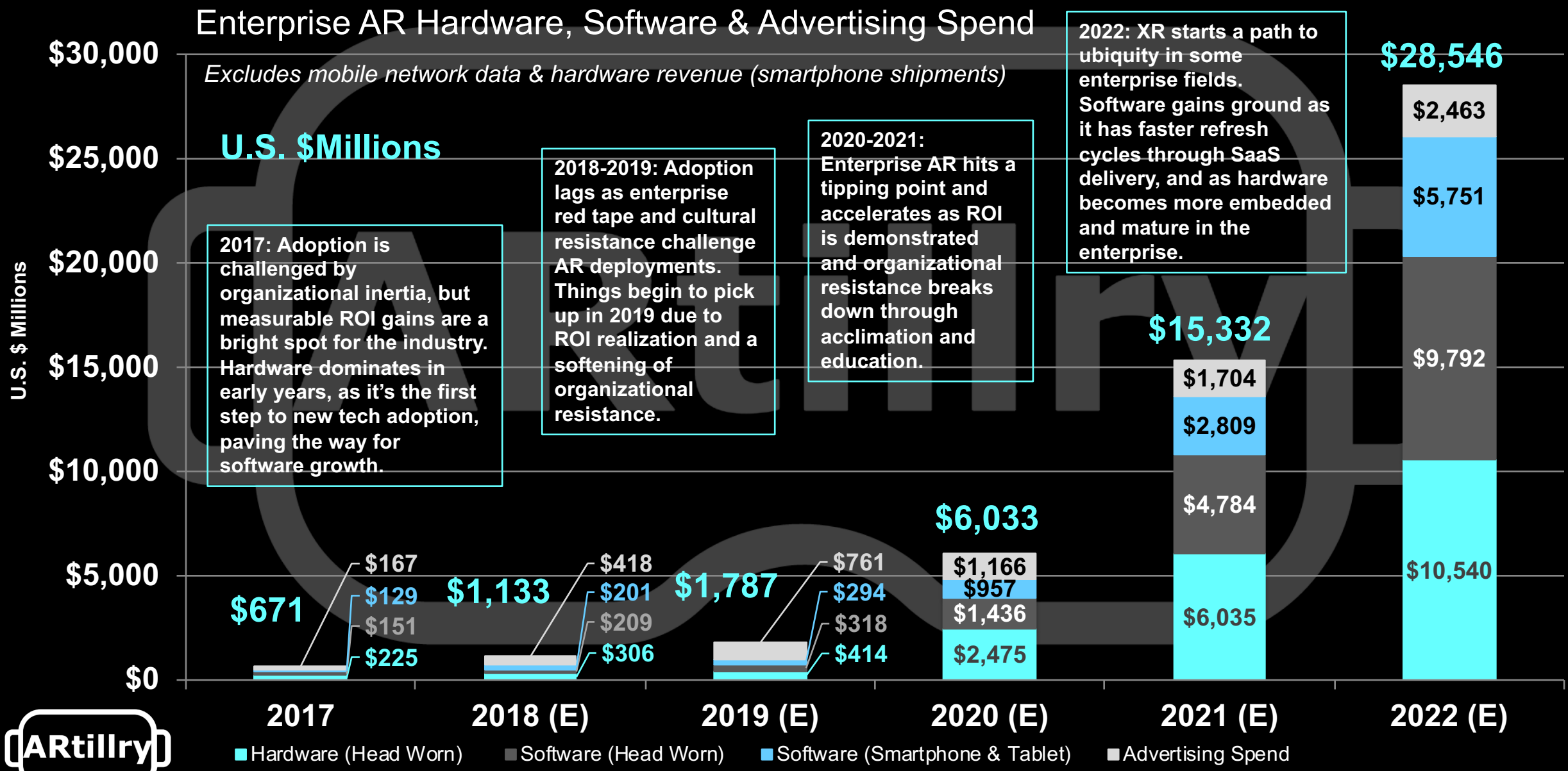
■ Software (Smartphone & Tablet)

■ Advertising Spend



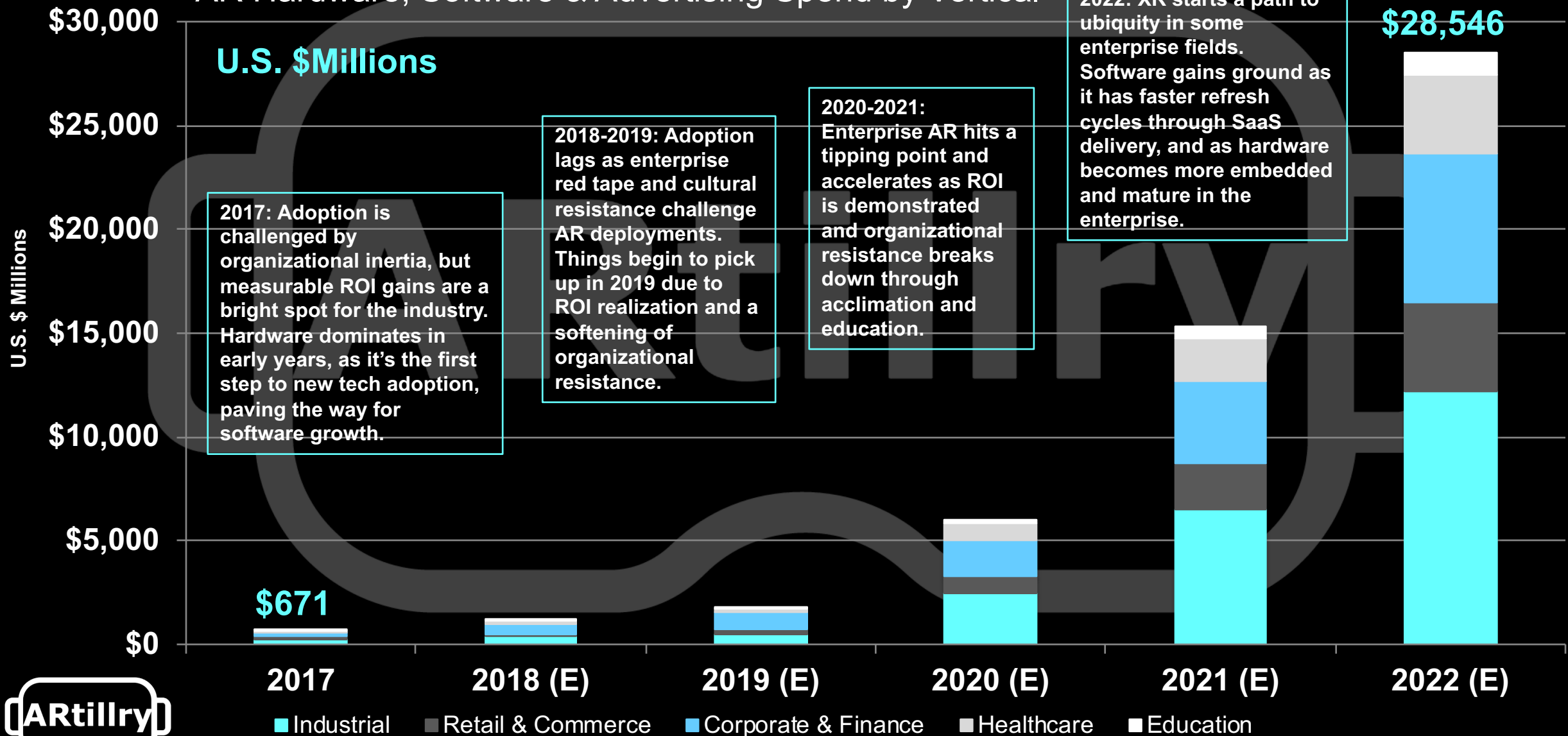
# ENTERPRISE AR DRILL DOWN

(DETAILED VIEW)



# ENTERPRISE AR DRILL DOWN

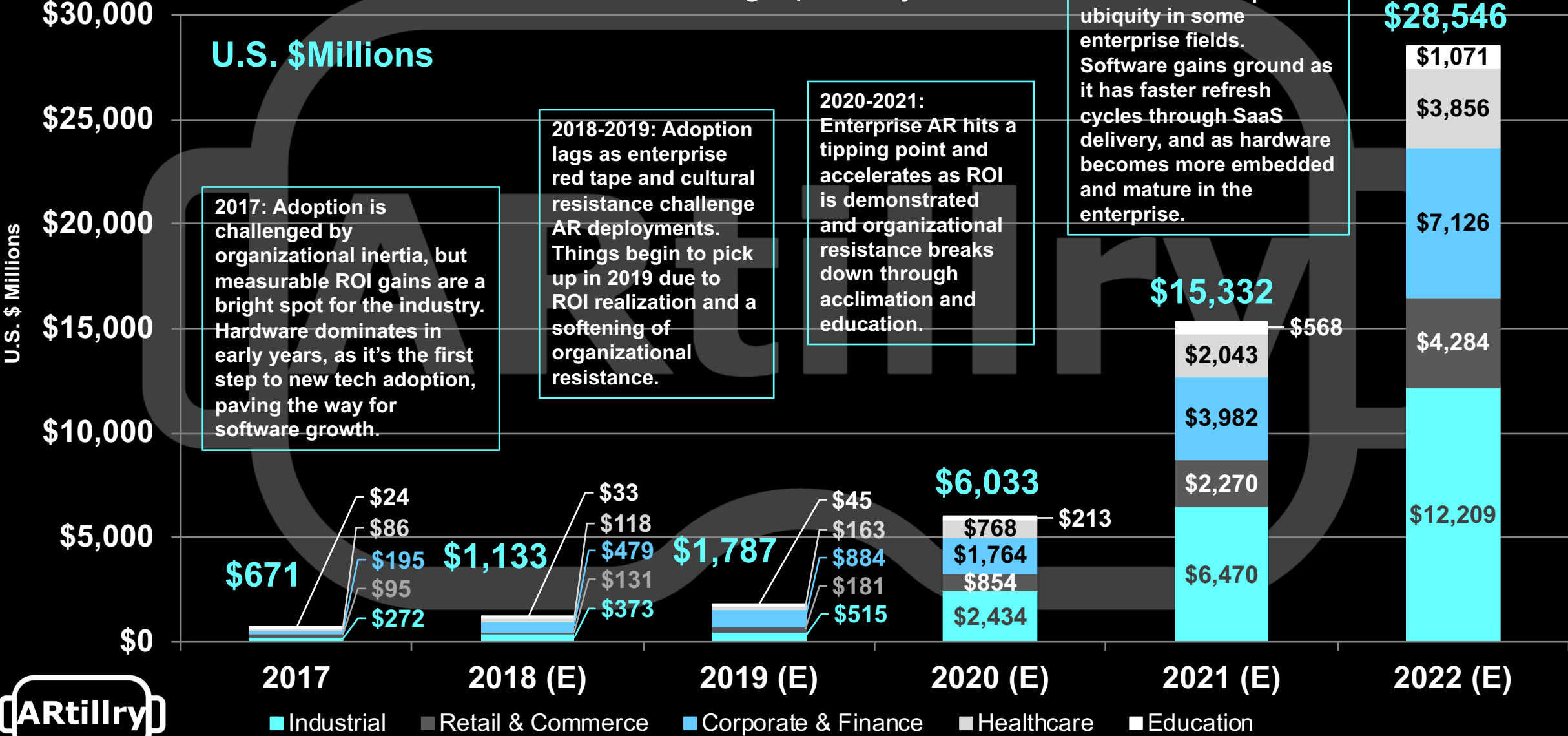
AR Hardware, Software & Advertising Spend by Vertical



# ENTERPRISE AR DRILL DOWN

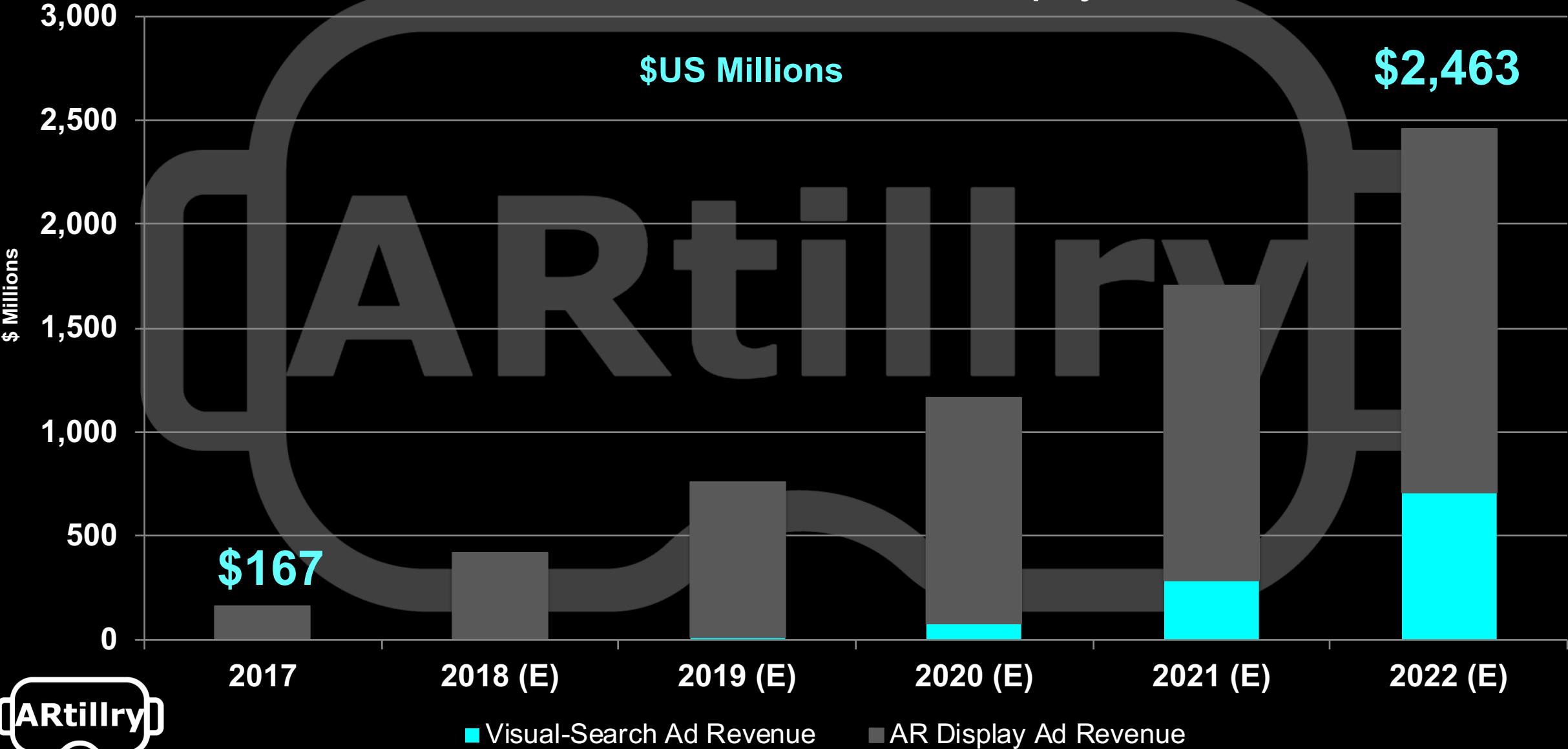
(DETAILED VIEW)

AR Hardware, Software & Advertising Spend by Vertical



# GLOBAL AR ADVERTISING BY FORMAT

Global AR ad revenues: search versus display (SIMPLIFIED VIEW)

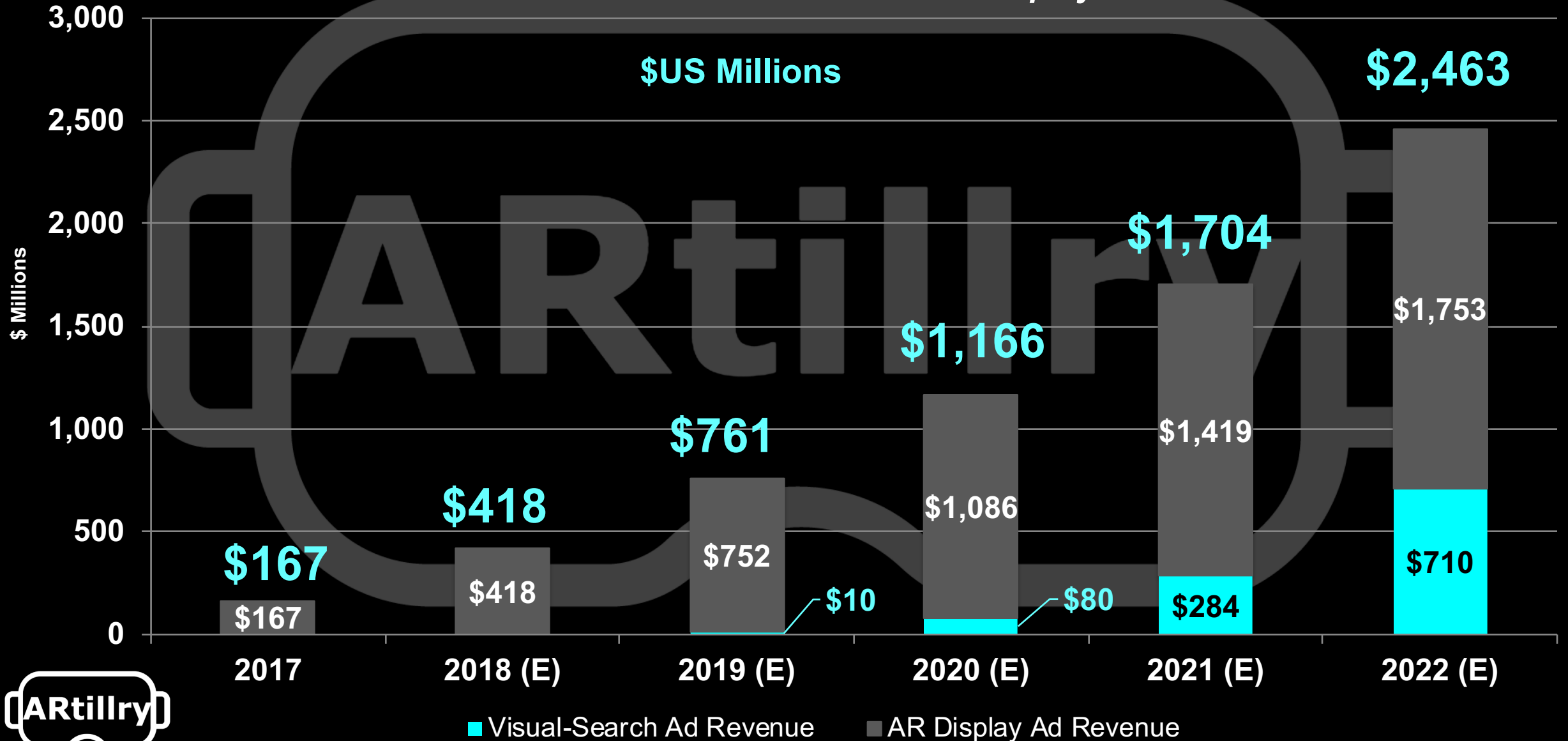




# GLOBAL AR ADVERTISING BY FORMAT

Global AR ad revenues: search versus display

(DETAILED VIEW)



# AR DEVICE FORECAST



# MOBILE AR: UNIT FORECAST

-  As mentioned, AR devices in the near term will mostly be smartphones, whose sales are not included in AR & VR revenue projections.
-  Mobile AR hardware (smartphones) isn't counted as AR revenue, because it's a ubiquitous consumer device on which AR's function is secondary.
-  However, quantifying smartphones' AR compatibility on a *unit penetration basis*, can be a leading indicator for mobile AR software revenue.
-  There are 2.6 billion smartphones globally, growing to 3.7 billion by 2022.
-  Of those, 994 million are AR compatible in 2018, growing to 3.4 billion (92 percent compatibility) by 2022.
-  This steep growth is driven by smartphone replacement cycles (2.5 years), which represent a phasing-in period for mobile AR.
-  This phasing-in process will differ between Arkit, ARCore and web AR.




# MOBILE AR: UNIT FORECAST (CONT')

 **Apple's ARkit will grow from 433 million compatible iPhones in 2017 to 701 million in 2022.**


 **ARkit has the nearer-term advantage, due to Apple's ability to mandate software updates across a more unified hardware base.**

 **Vertical integration also lets it fine tune sensor calibration**

 **Google's ARCore will grow from 44 million compatible phones in 2017 to 2.6 billion in 2022.**

 **ARCore is disadvantaged in the near-term, due to Android's fragmented hardware base that inhibits comprehensive software updates.**

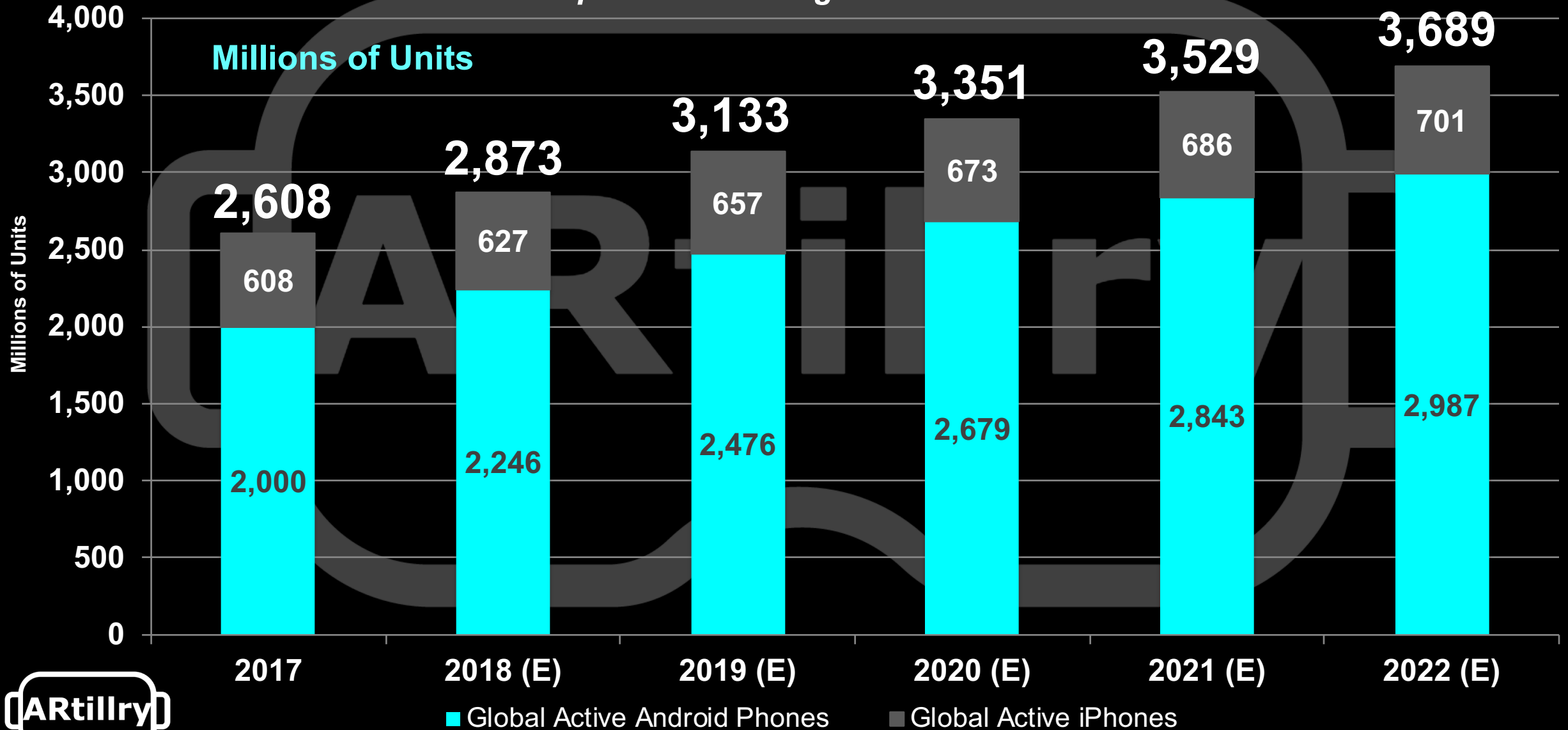
 **However it has a longer-term advantage in scale: The Android universe (2 billion devices) is much larger than iOS (600 million devices).**

 **Collectively, mobile AR's installed base will incentivize developers to build content and apps, and serve as a training ground for an eventual glasses-dominant era.**



# IOS AND ANDROID INSTALLED BASE

*Global Active Smartphones Running Android or iOS*

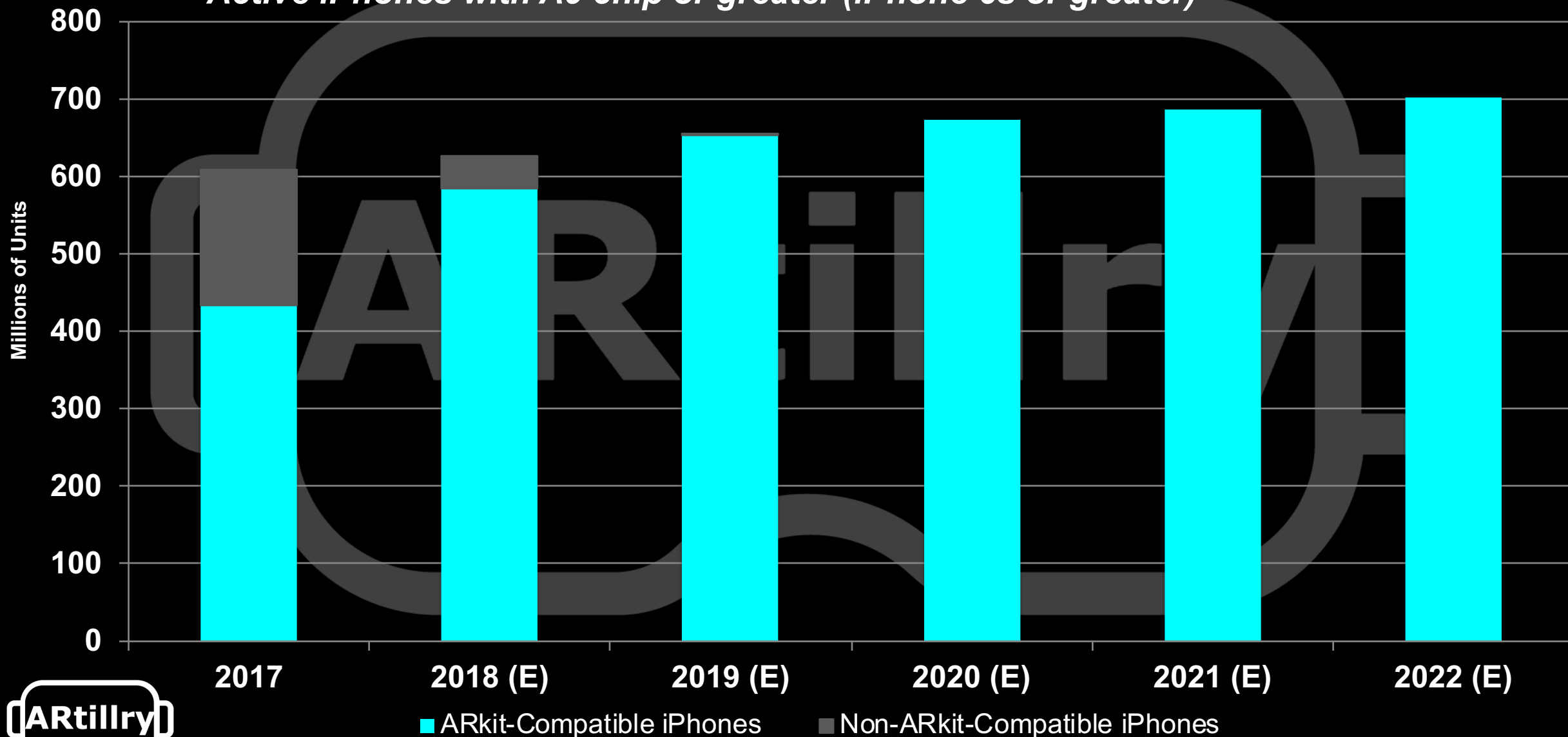


# ARKIT INSTALLED BASE

(SIMPLIFIED VIEW)

Millions of Units

*Active iPhones with A9 chip or greater (iPhone 6s or greater)*

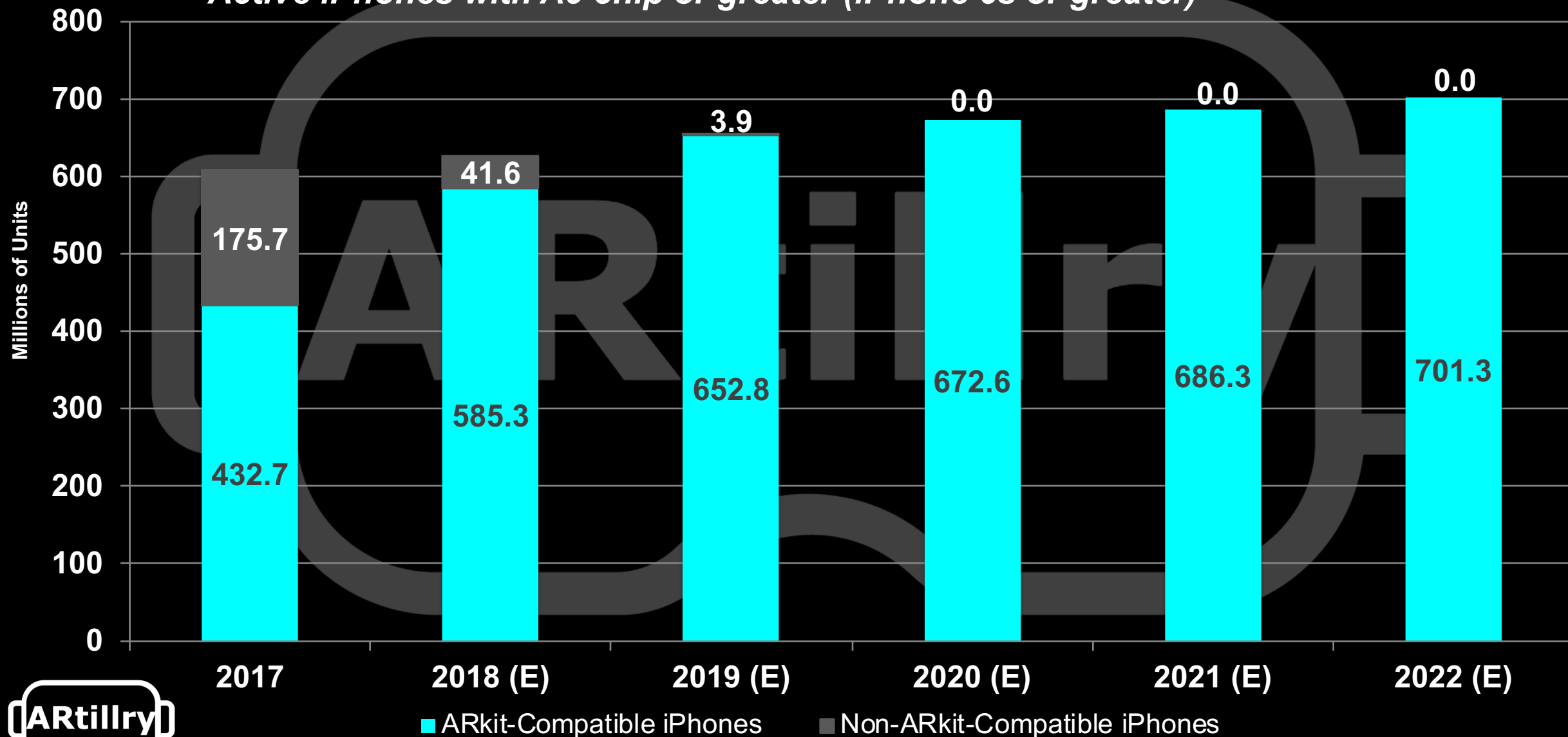


# ARKIT INSTALLED BASE

(DETAILED VIEW)

Millions of Units

Active iPhones with A9 chip or greater (iPhone 6s or greater)

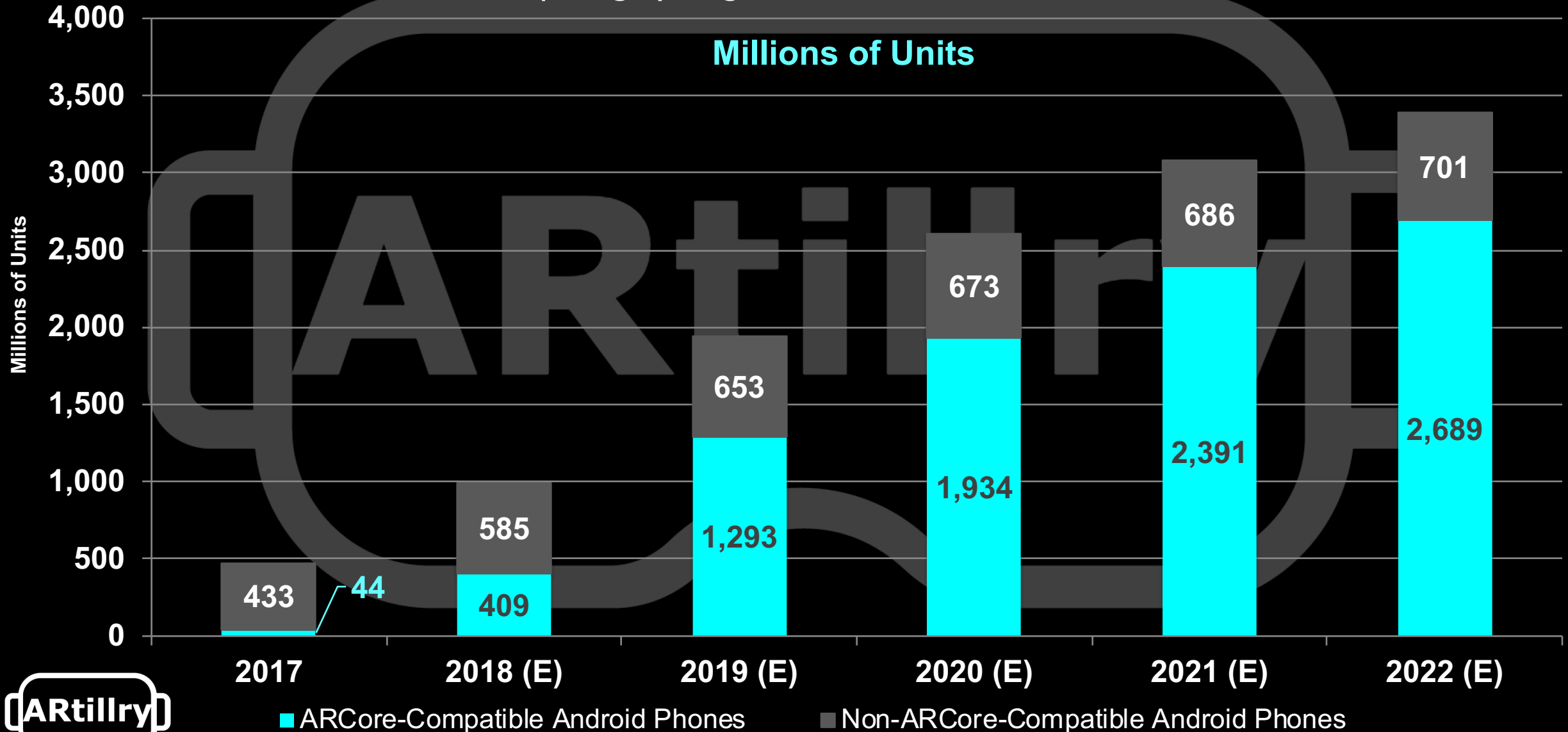




# ARCore INSTALLED BASE

(DETAILED VIEW)

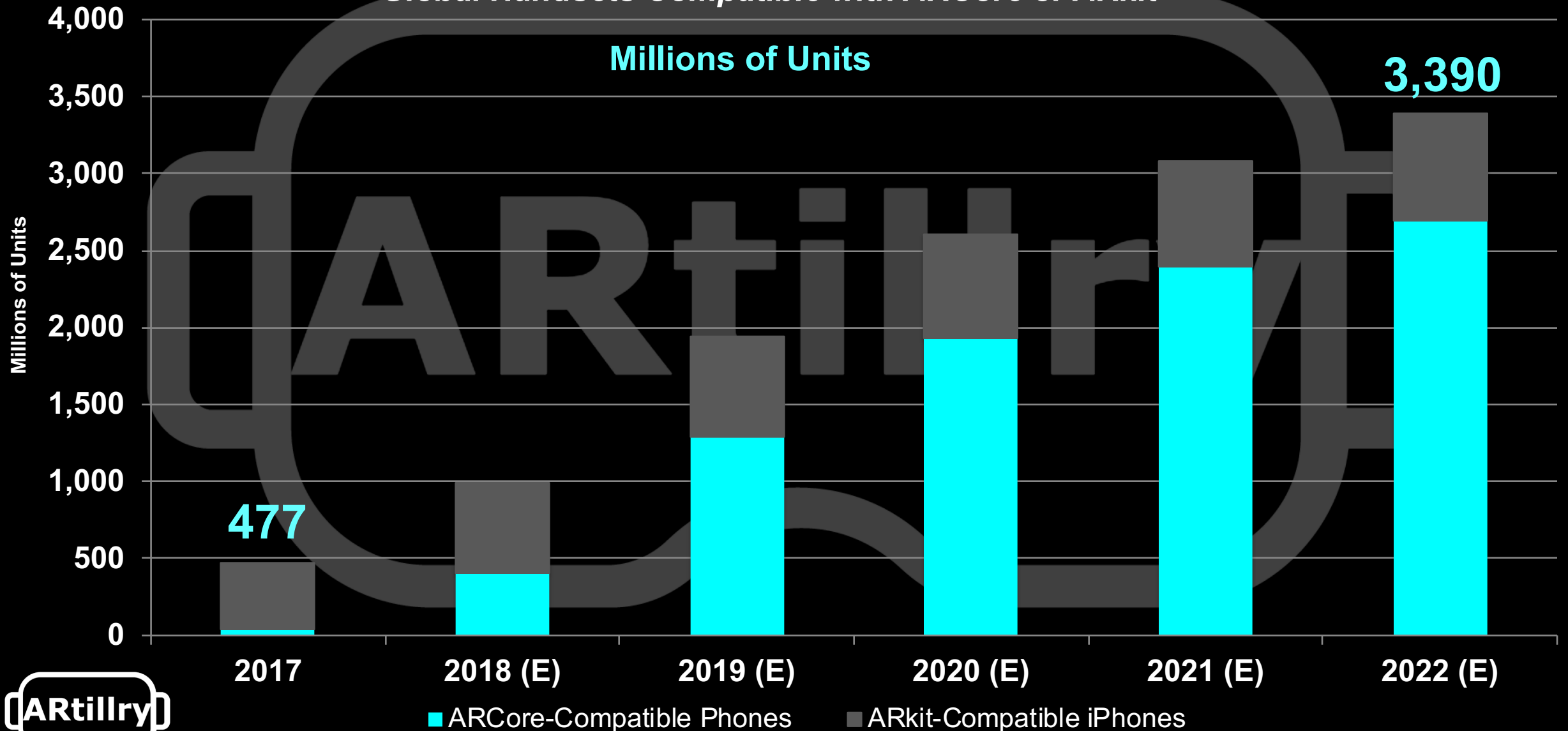
*Phones with Android 7.0 (Nougat) or greater, and deliberate sensor calibration for ARCore*



# ARCore + ARKit INSTALLED BASE

*Global Handsets Compatible with ARCore or ARKit*

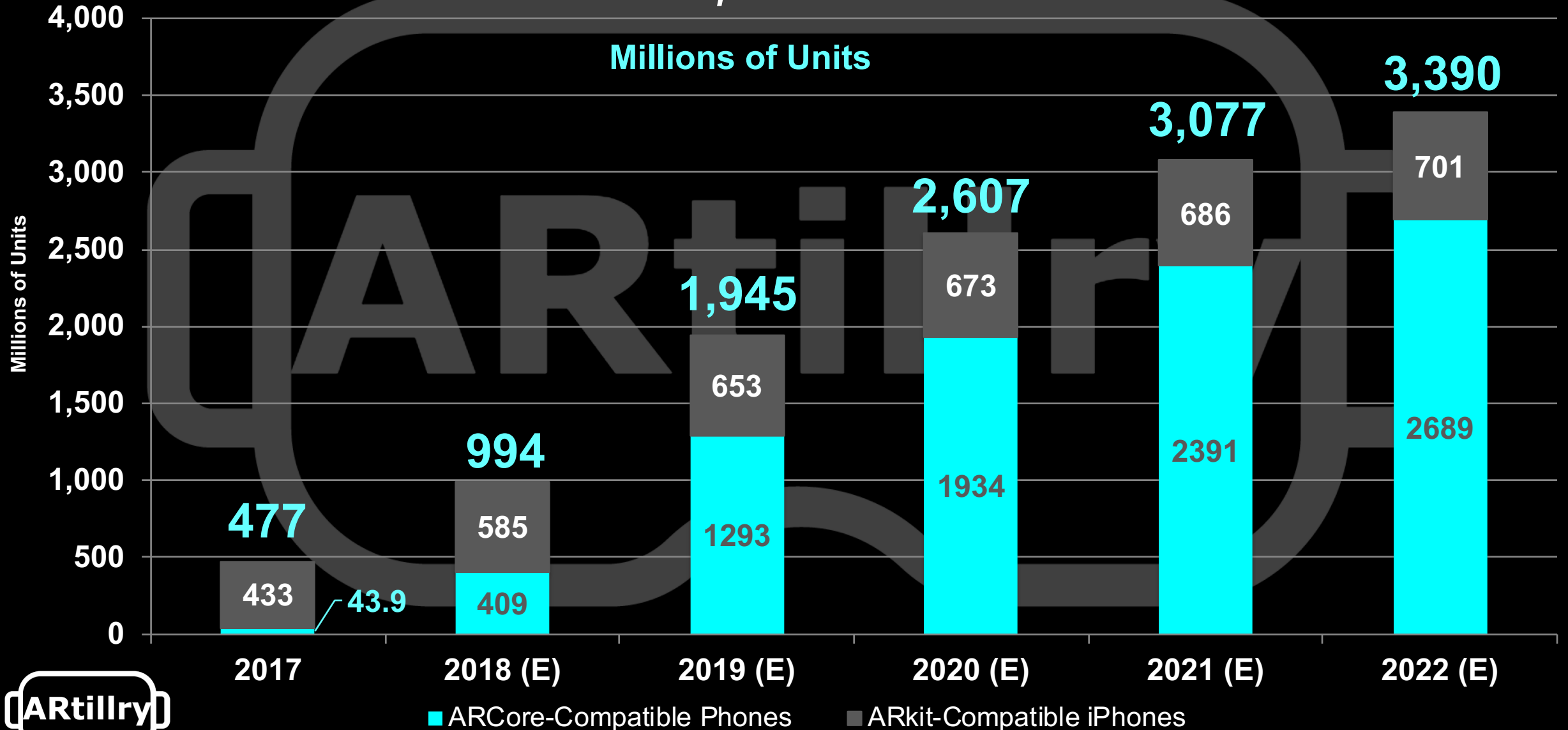
*(SIMPLIFIED VIEW)*



# ARCore + ARKit INSTALLED BASE

Global Handsets Compatible with ARCore or ARKit

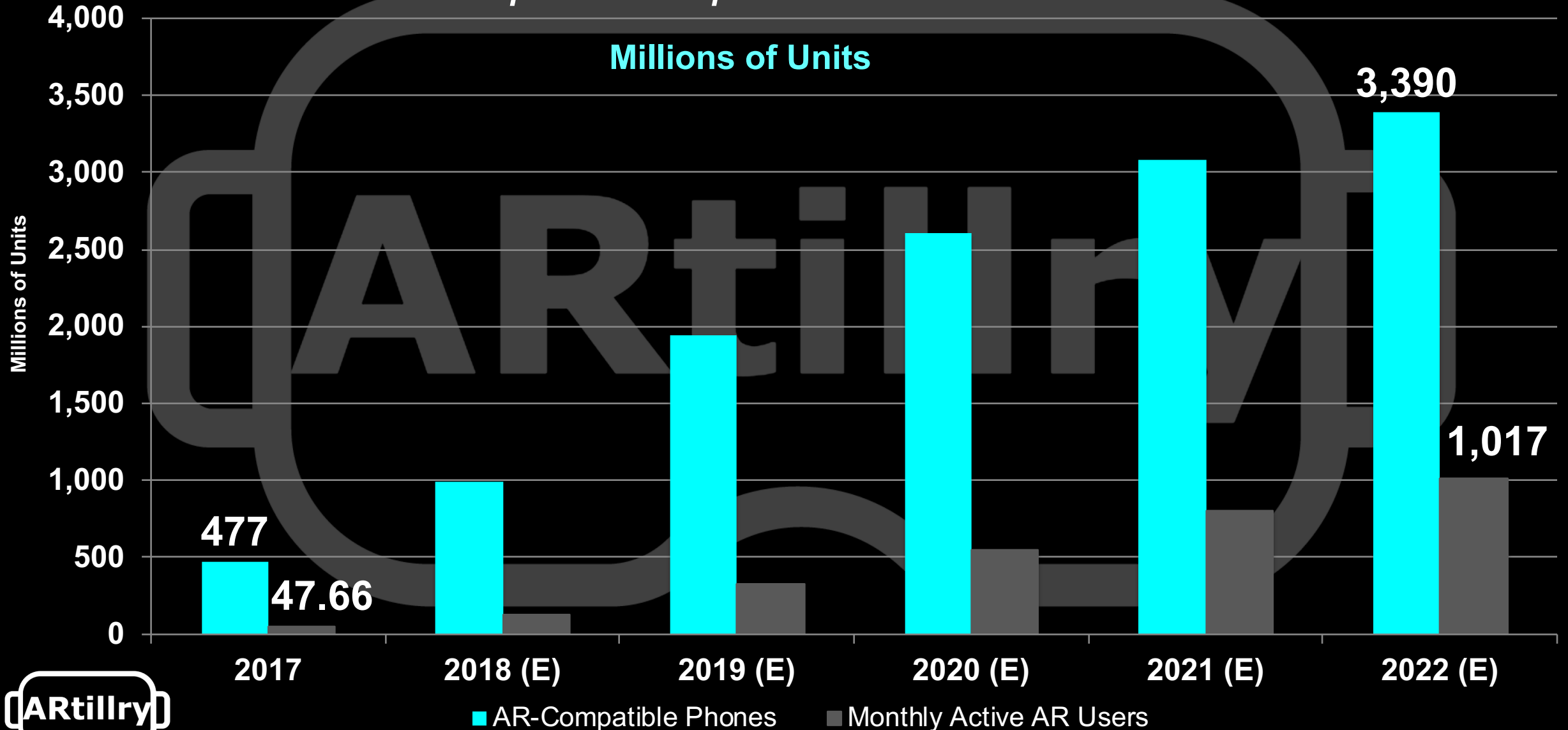
(DETAILED VIEW)



# ARCORE + ARKIT INSTALLED BASE

*AR-Compatible smartphones versus active users*

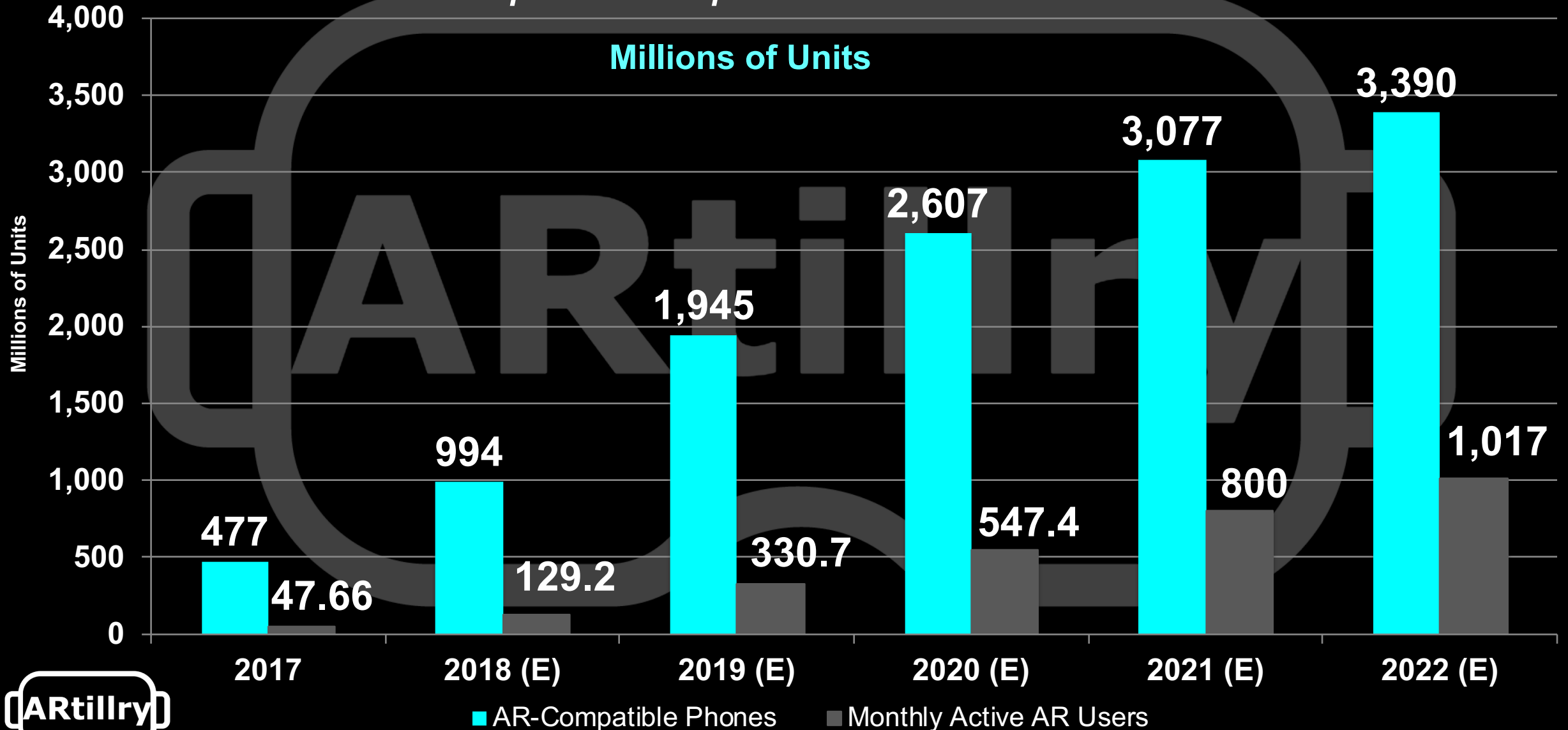
*(SIMPLIFIED VIEW)*



# ARCORE + ARKIT INSTALLED BASE

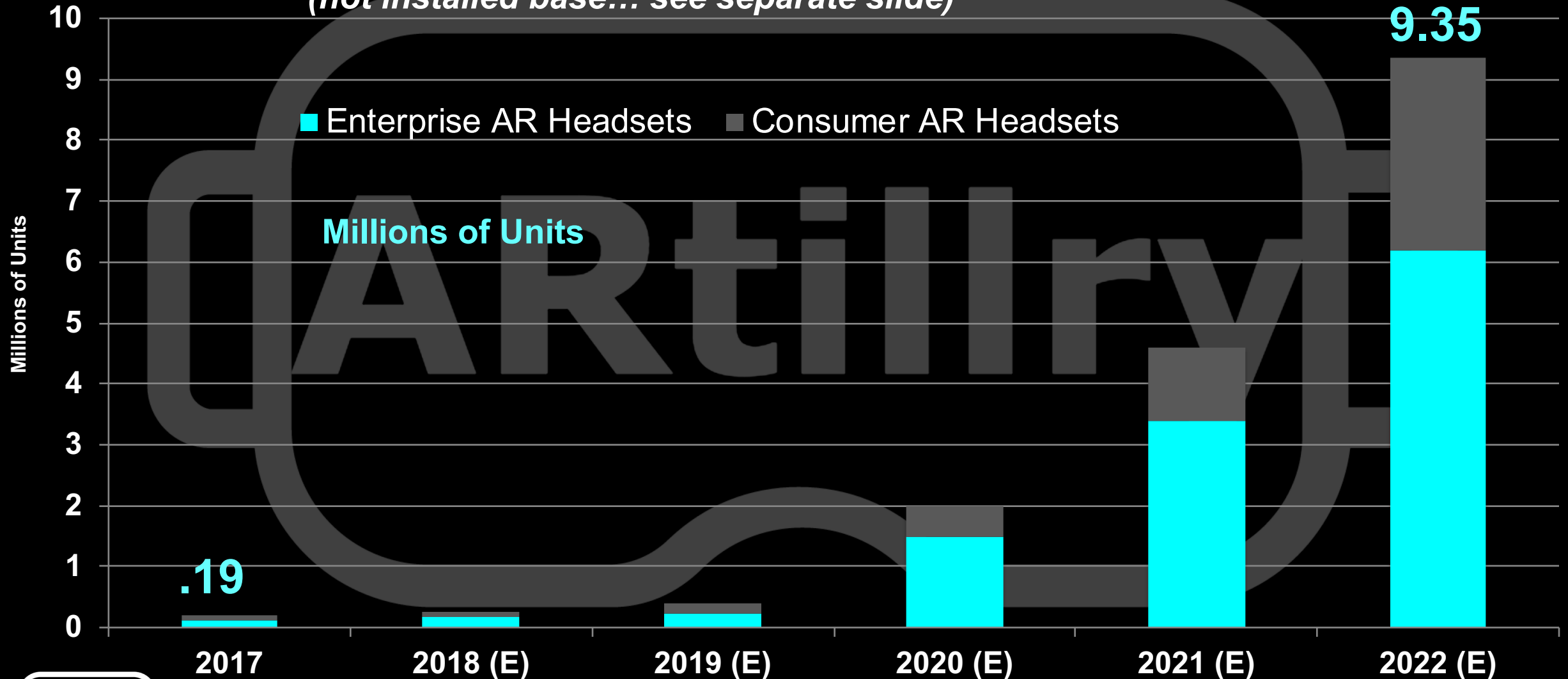
AR-Compatible smartphones versus active users

(DETAILED VIEW)



# AR HEADSET ANNUAL SALES

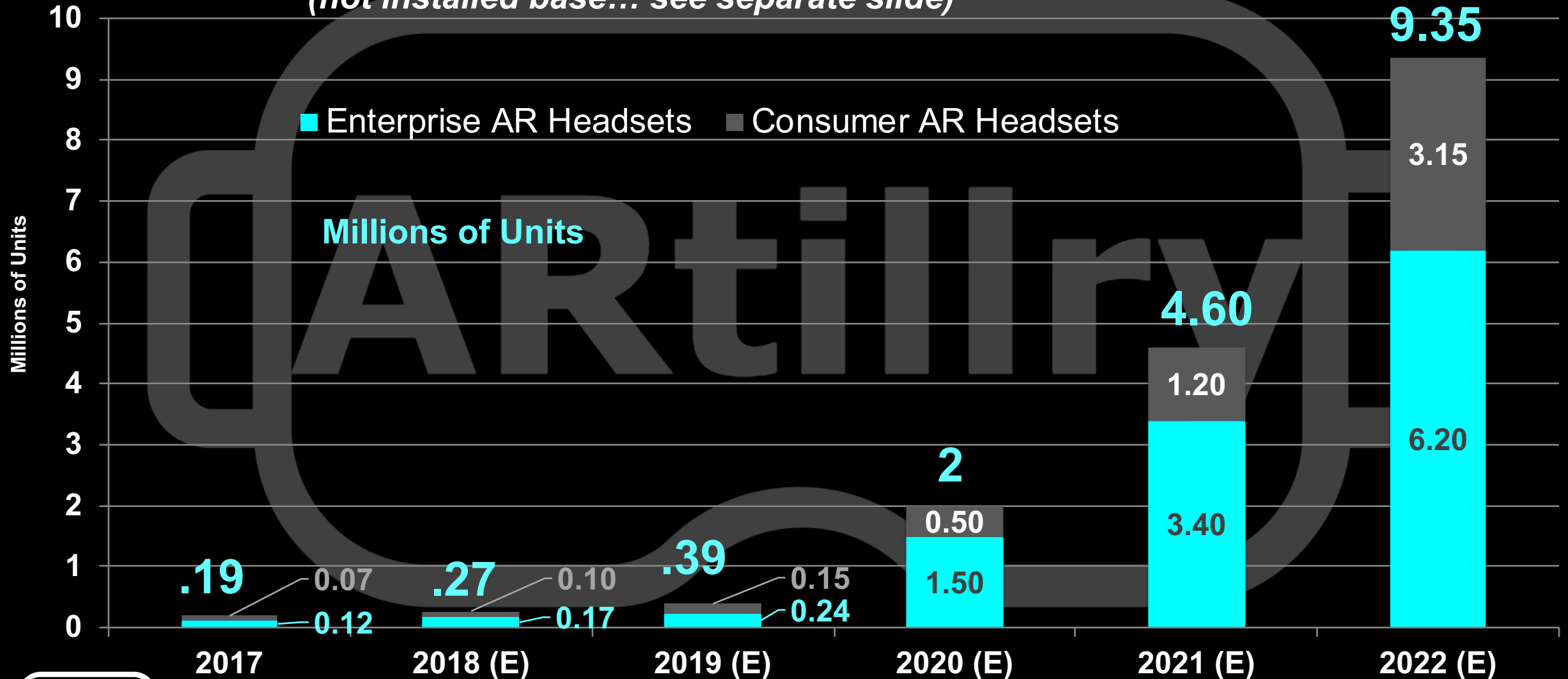
*(not installed base... see separate slide)*



*(SIMPLIFIED VIEW)*

# AR HEADSET ANNUAL SALES

(not installed base... see separate slide)

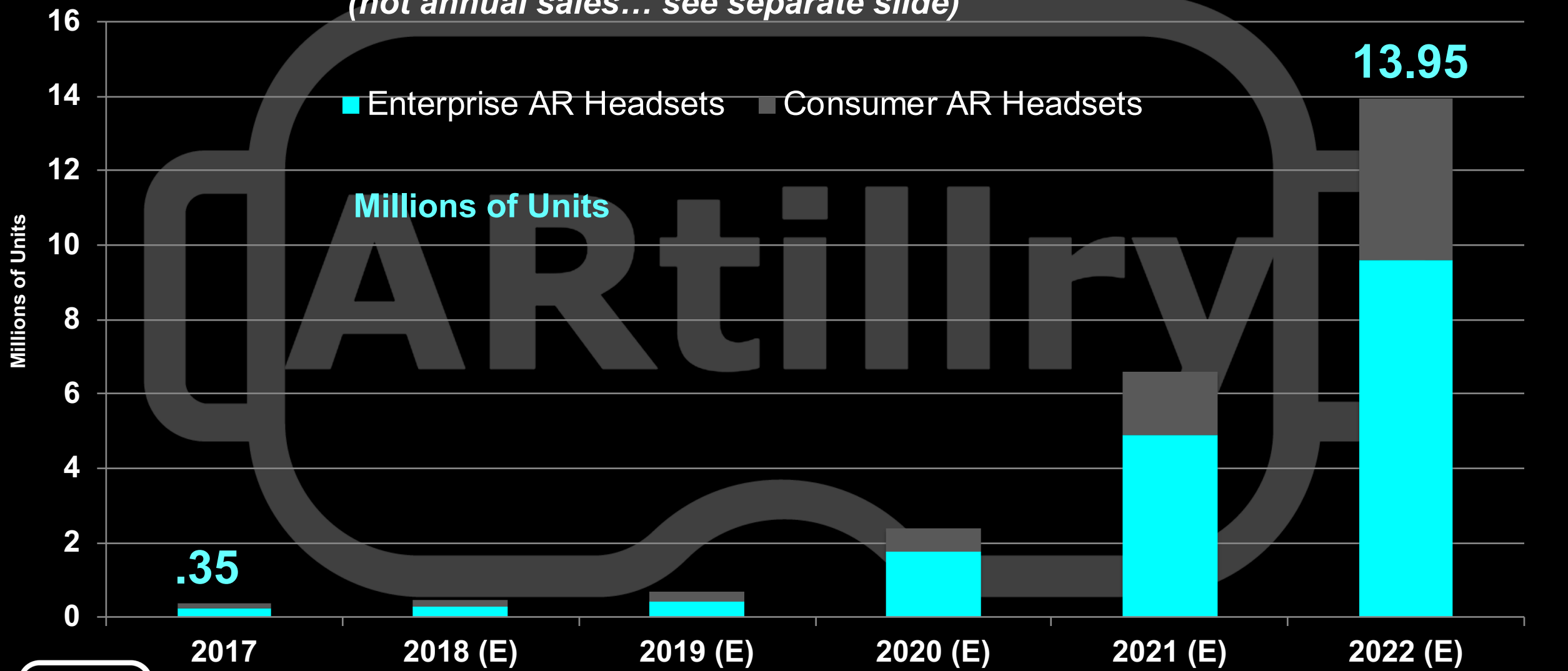


(DETAILED VIEW)



# AR HEADSET INSTALLED BASE

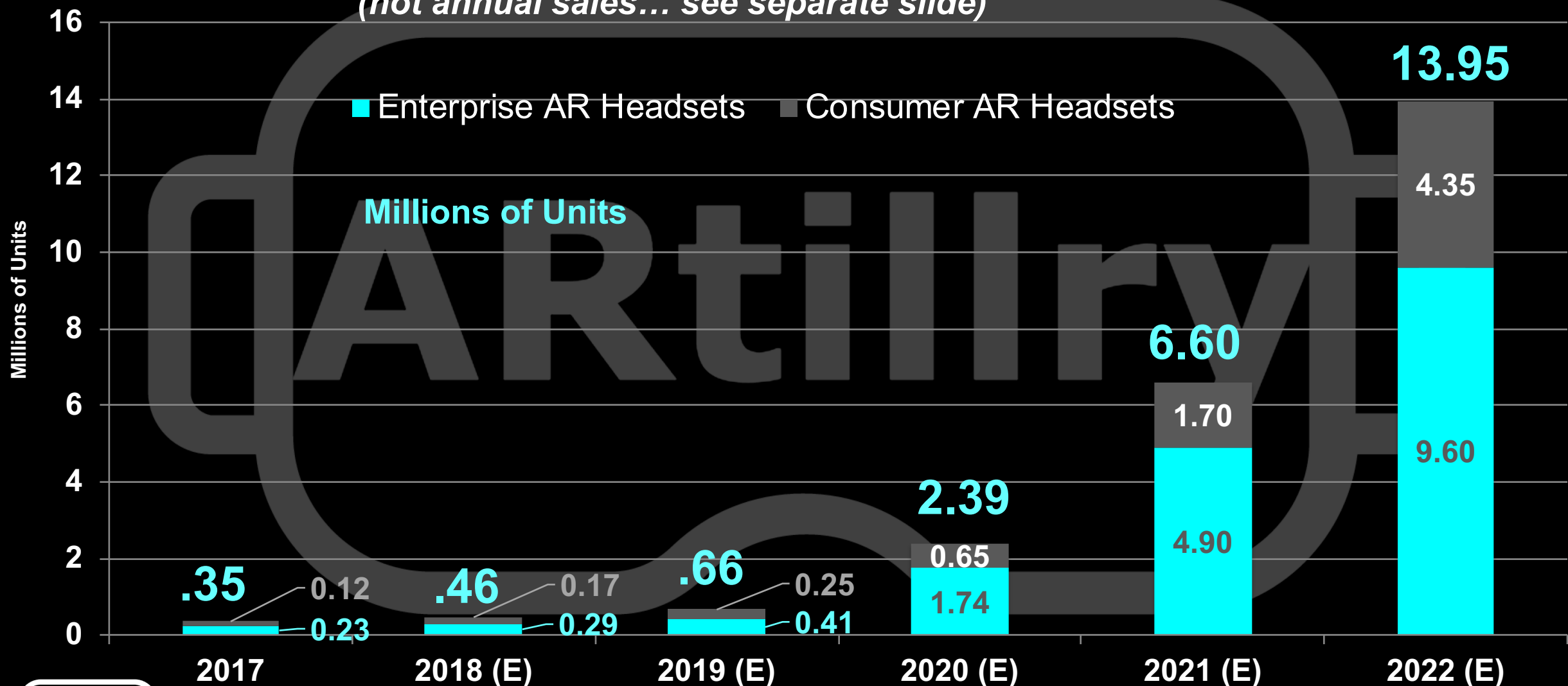
(not annual sales... see separate slide)



(SIMPLIFIED VIEW)

# AR HEADSET INSTALLED BASE

(not annual sales... see separate slide)




(DETAILED VIEW)

# DRILLING DOWN ON VR




# GLOBAL VR REVENUES

 Global VR product revenues will grow from U.S. \$2.7 billion in 2017 to U.S. \$11.4 billion in 2022, a 33% compound annual growth rate (CAGR).

 The largest share of VR revenue in 2017 was consumer VR (88%), which continues to dominate through 2022, but lose some share to enterprise VR.

 Enterprise comprises 12% of VR revenues in 2017 and 25% in 2022.\*

 Consumer comprises 88% of VR revenues in 2017 and 75% in 2022.

 Consumer VR's dominance results from the form factor's alignment with consumer-gearred use cases, such as gaming and entertainment.

 Consumer VR has taken an early lead, due mostly to gaming but enterprise VR adoption will accelerate as ROI is demonstrated.

 The HTC Vive Pro will benefit most from enterprise adoption, and its higher price tag will shift overall revenue share towards enterprise VR.



\*This includes VR hardware and software sales only. It does not include professional services such as enterprise consulting. See slide 5.

# GLOBAL VR REVENUE OVERVIEW

## VR Hardware, Software & LBVR Revenues

Headsets, Games, Apps, Enterprise Software, Ads, LBVR Admissions

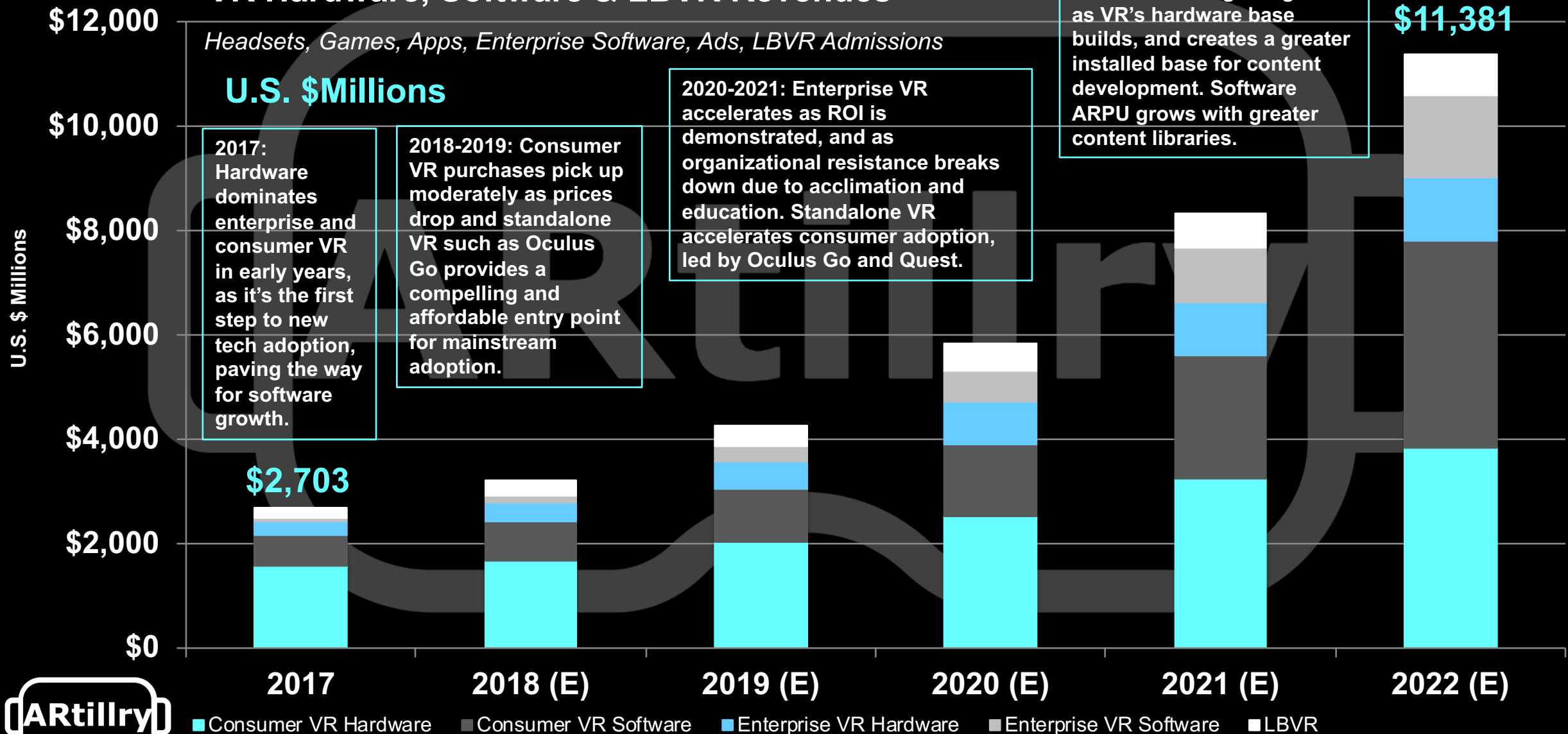
**U.S. \$Millions**

2017: Hardware dominates enterprise and consumer VR in early years, as it's the first step to new tech adoption, paving the way for software growth.

2018-2019: Consumer VR purchases pick up moderately as prices drop and standalone VR such as Oculus Go provides a compelling and affordable entry point for mainstream adoption.

2020-2021: Enterprise VR accelerates as ROI is demonstrated, and as organizational resistance breaks down due to acclimation and education. Standalone VR accelerates consumer adoption, led by Oculus Go and Quest.

2022: Software gains ground as VR's hardware base builds, and creates a greater installed base for content development. Software ARPU grows with greater content libraries.



# GLOBAL VR REVENUE OVERVIEW

(DETAILED VIEW)

## VR Hardware, Software & LBVR Revenues

Headsets, Games, Apps, Enterprise Software, Ads, LBVR Admissions

U.S. \$Millions

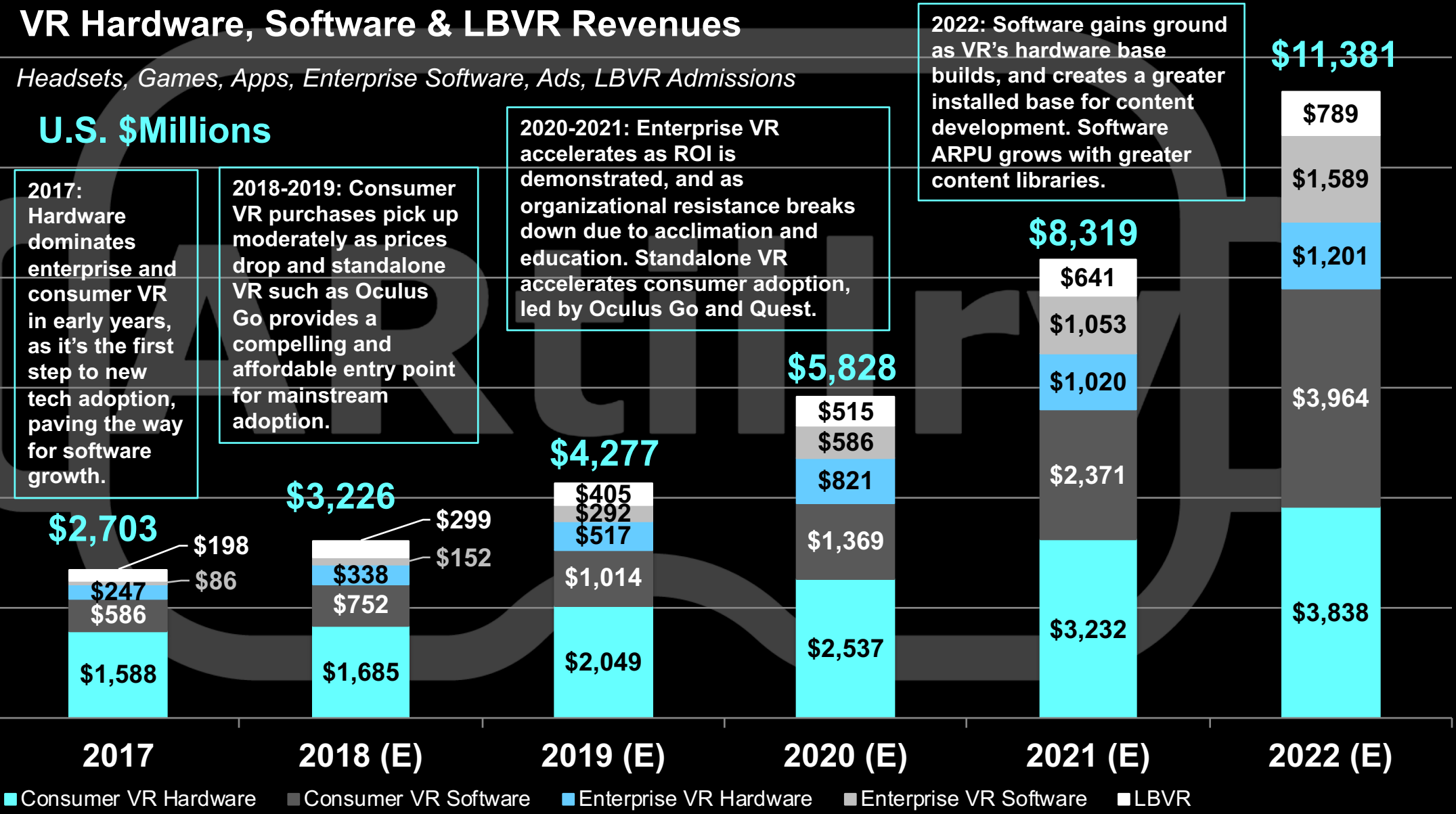
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U.S. \$ Millions









# CONSUMER VR DRILL DOWN





# CONSUMER VR REVENUES

-  One of consumer VR hardware's greatest adoption drivers will be price competition among headset manufacturers (e.g. Oculus, Sony, Samsung).
-  Oculus Go, at a \$199 price point, will hit a sweet spot for quality, affordability, and an established content library from Gear VR's tenure.
-  Holidays 2018 will be a "moment of truth" for Oculus Go, as the above advantages plus a gift-able price point could jumpstart VR adoption.
-  Consumer VR revenues will be led by hardware in the near term, shifting over time to software.
-  VR software will overtake hardware in 2022 as headset revenue growth matures, and as software refresh rates outpace hardware replacement cycles. Greater content libraries will also boost consumer spending.
-  Within VR software, premium app revenue rules, but web VR will gain share over time as evolving capability and lack of friction attract users.



\*See the next section for a breakdown of headset pricing and unit sales trending

# CONSUMER VR DRILLDOWN

## VR Hardware, Software & LBVR Revenues

Headsets, Games, Apps, LBVR Admissions

U.S. \$Millions

2017: Hardware dominates VR in early years, as it's the first step to new tech adoption, paving the way for content creation with a greater installed base. Growth starts slow however.

2018-2019: Consumer VR purchases start to pick up as prices drop and standalone VR such as Oculus Go provides a more compelling and affordable entry point for mainstream consumers.

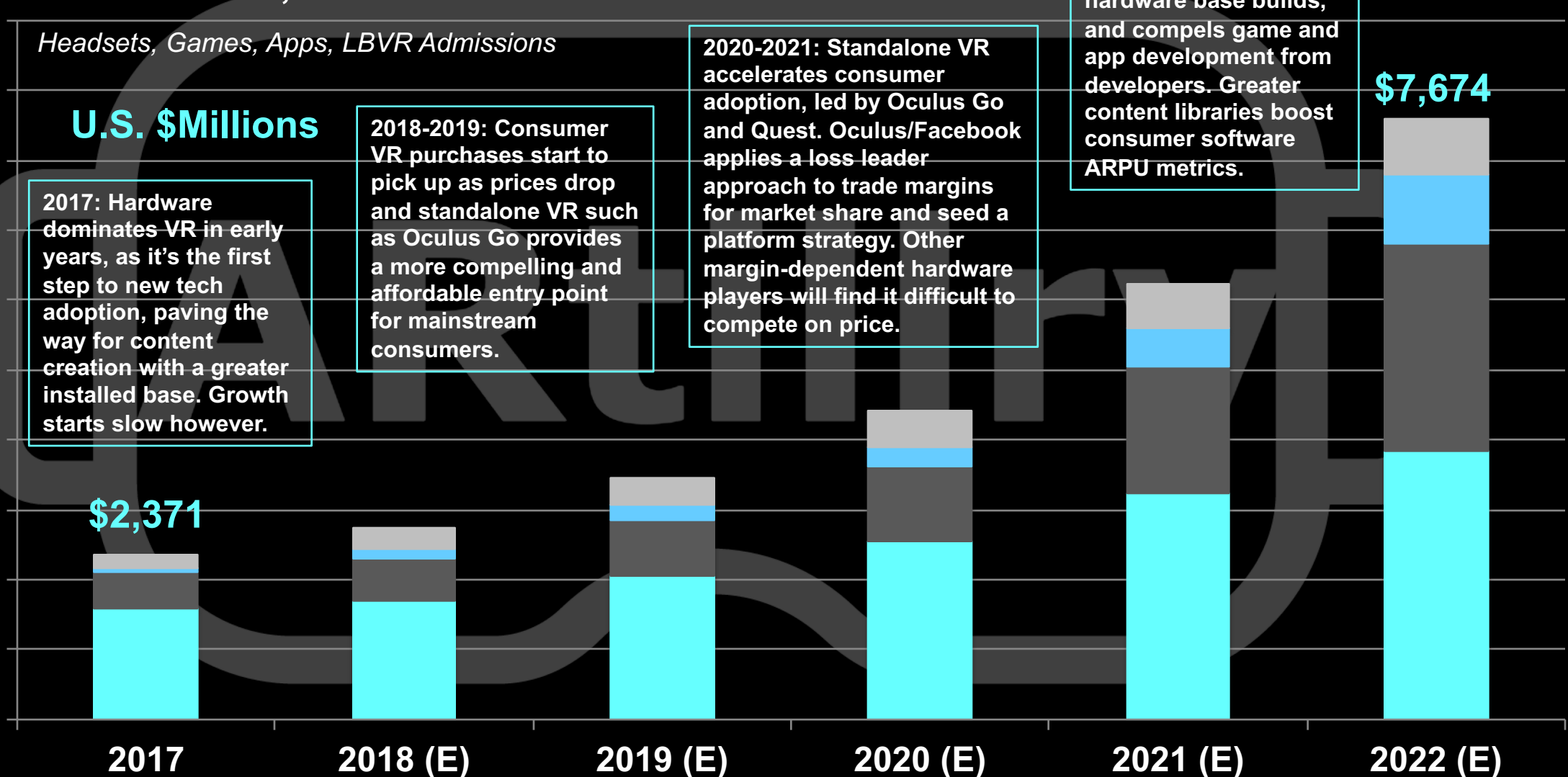
2020-2021: Standalone VR accelerates consumer adoption, led by Oculus Go and Quest. Oculus/Facebook applies a loss leader approach to trade margins for market share and seed a platform strategy. Other margin-dependent hardware players will find it difficult to compete on price.

2022: Software gains ground as VR's hardware base builds, and compels game and app development from developers. Greater content libraries boost consumer software ARPU metrics.

U.S. \$ Millions



■ Consumer VR Hardware ■ Premium Apps/Games ■ In-App/Game Purchases ■ LBVR



# CONSUMER VR DRILLDOWN

(DETAILED VIEW)

## VR Hardware, Software & LBVR Revenues

Headsets, Games, Apps, LBVR Admissions

U.S. \$Millions

2017: Hardware dominates VR in early years, as it's the first step to new tech adoption, paving the way for content creation with a greater installed base. Growth starts slow however.

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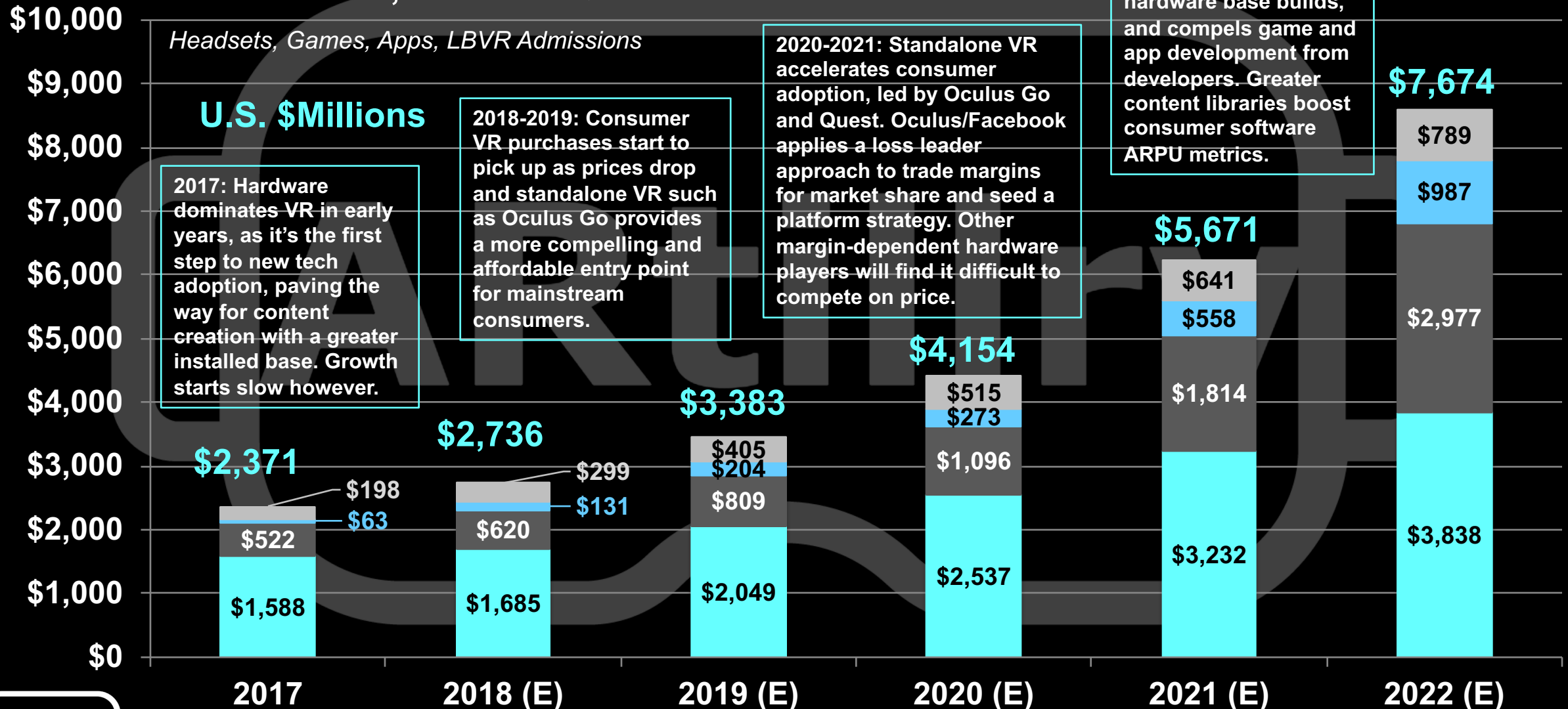
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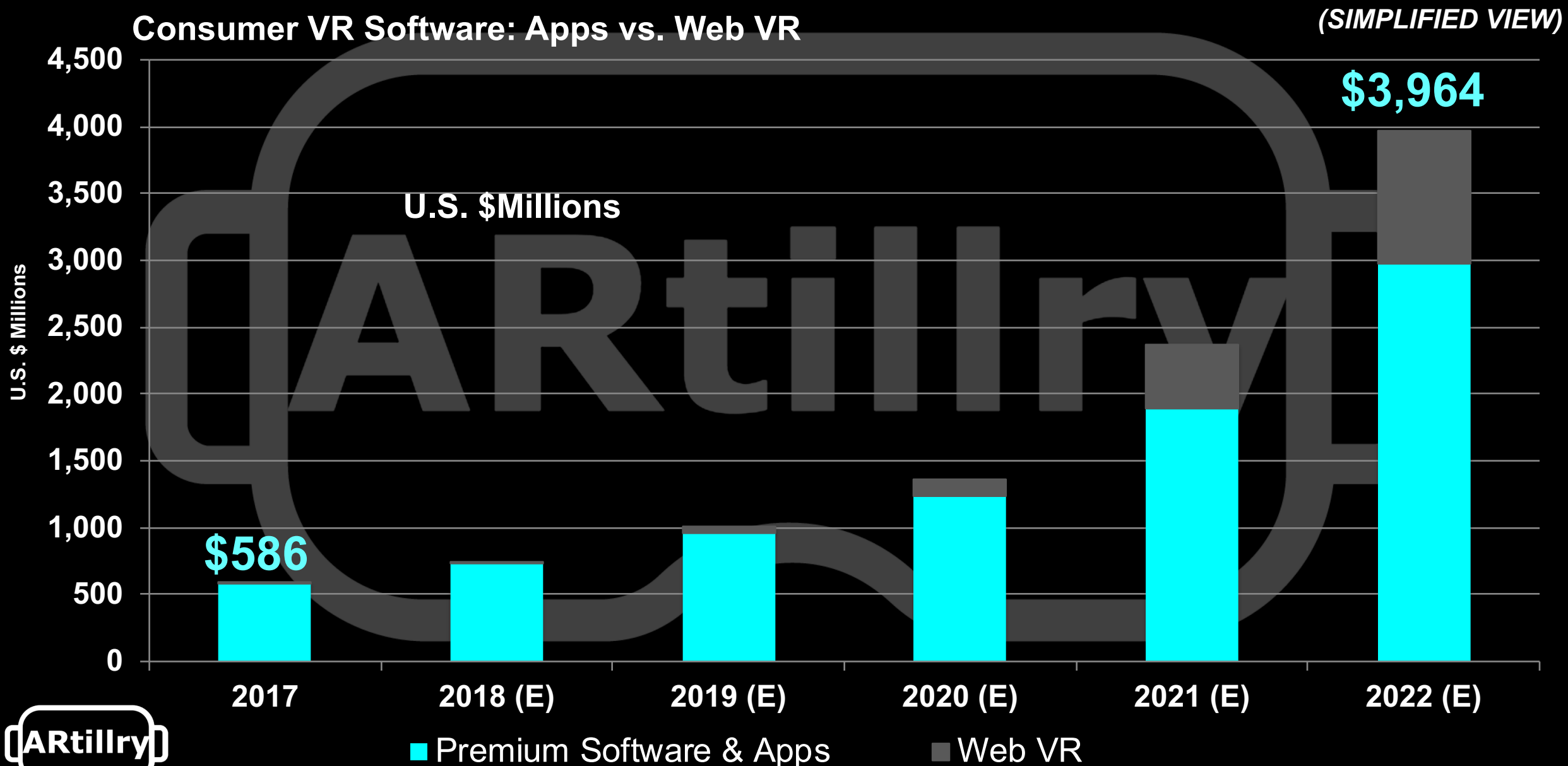
U.S. \$ Millions



■ Consumer VR Hardware ■ Premium Apps/Games ■ In-App/Game Purchases ■ LBVR



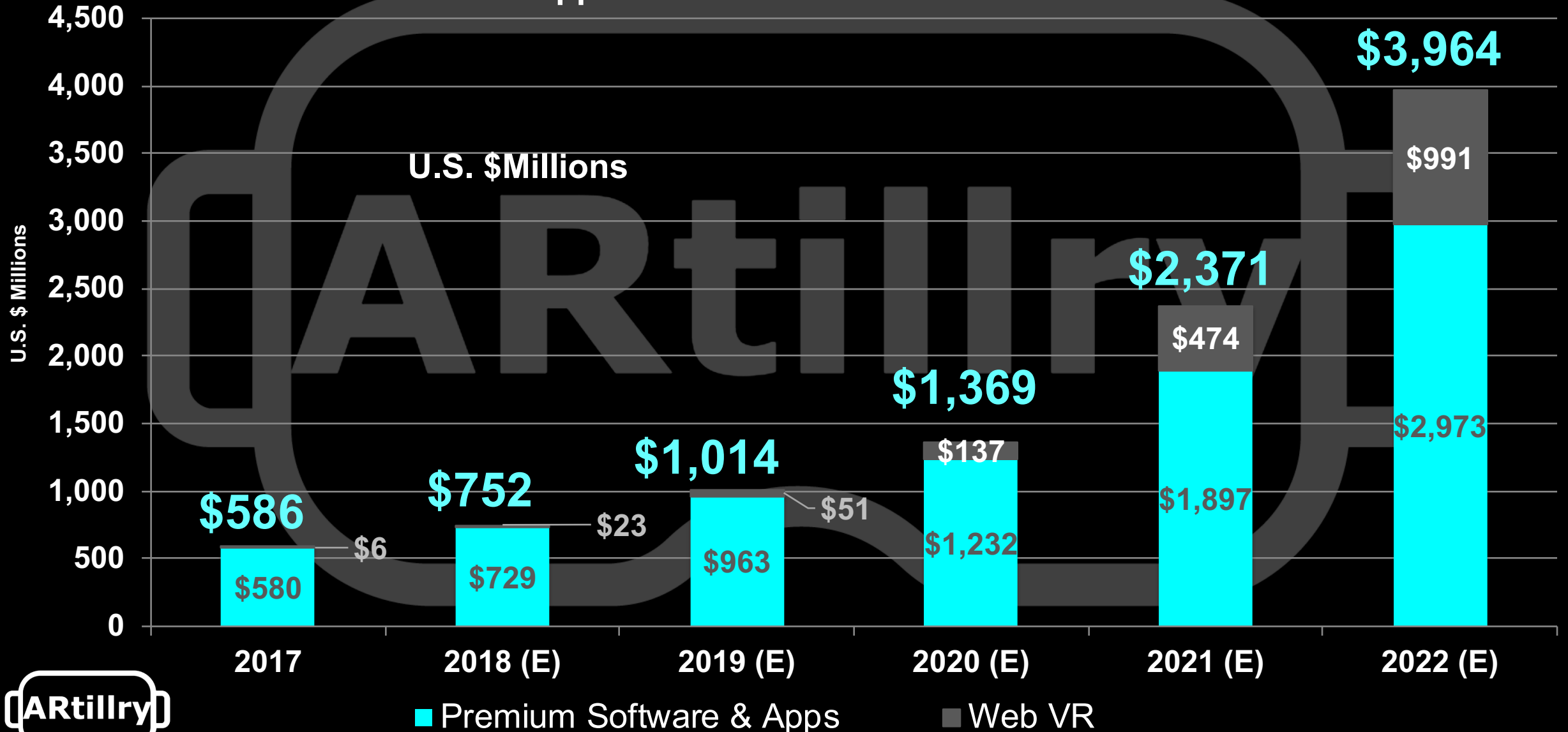
# CONSUMER VR SOFTWARE DRILL DOWN



# CONSUMER VR SOFTWARE DRILL DOWN

(DETAILED VIEW)









Consumer VR Software: Apps vs. Web VR



# **ENTERPRISE VR DRILL DOWN**



# ENTERPRISE VR REVENUES

-  Enterprise VR revenue trails consumer VR and other XR sub-sectors, due to limited hours of eligible use per working day.
  -  VR's isolation inhibits industrial job functions and hand work.
  -  VR's will excel in corporate, finance (data visualization) and training.
-  Like Consumer VR, Enterprise VR revenues will be led by hardware in the near term, shifting over time to software.
  -  Hardware often dominates early stages of enterprise technology adoption, creating an installed base for software growth.
  -  VR software will overtake hardware in 2022 as software refresh rates (likely sold in a SaaS format) outpace hardware replacement cycles.
-  Near-term advertising spend is relatively low in VR, due to usage levels.
  -  Ad inventory is constrained, as is advertiser reach, interest and fill rates.\*



\* ARtillery Intelligence does not include creative production costs, nor marketing-based brand apps in ad spend figures (only paid ad placements).

# ENTERPRISE VR DRILL DOWN

## VR Hardware, Software & Ad Revenues

Headsets, Software, Advertising spend

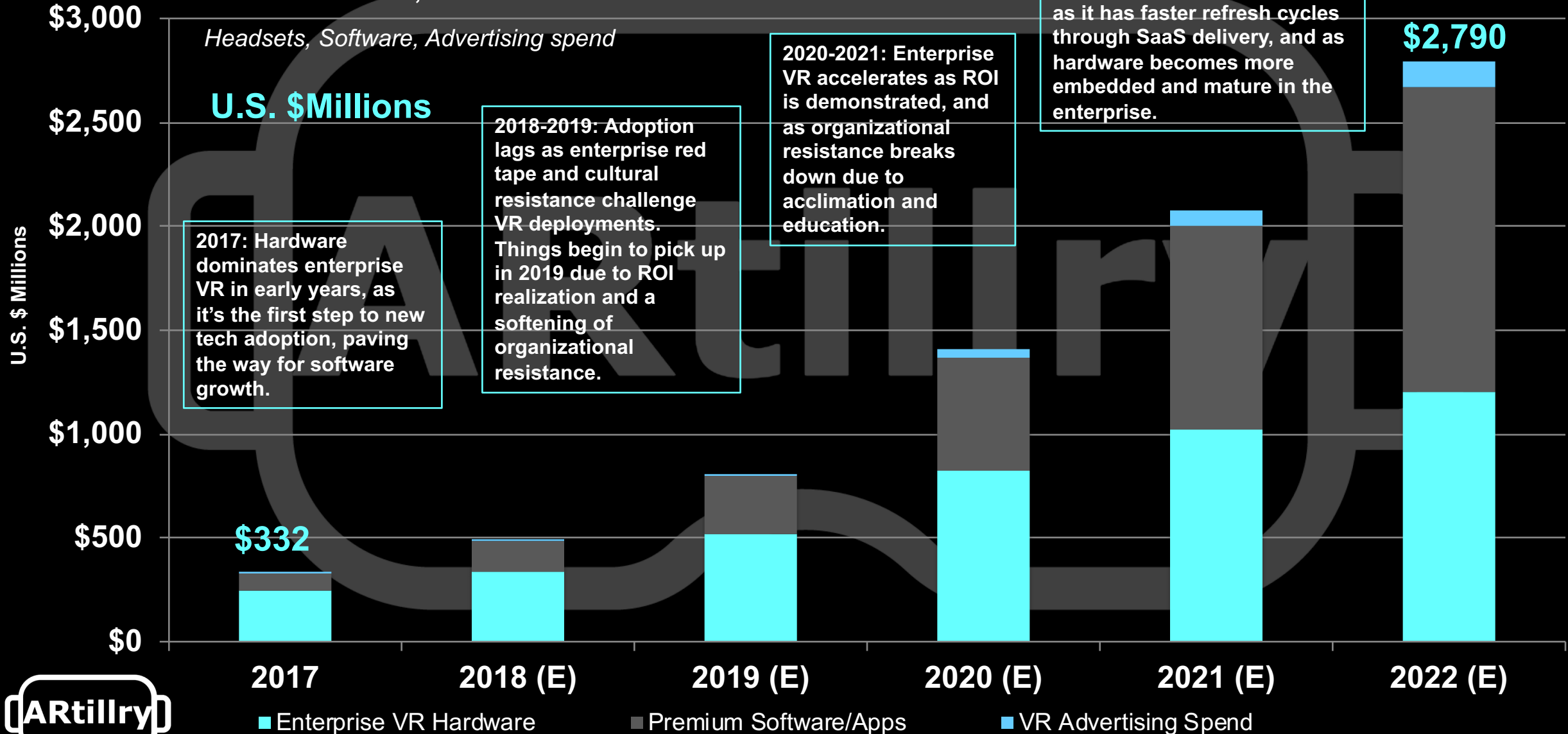
U.S. \$Millions

2017: Hardware dominates enterprise VR in early years, as it's the first step to new tech adoption, paving the way for software growth.

2018-2019: Adoption lags as enterprise red tape and cultural resistance challenge VR deployments. Things begin to pick up in 2019 due to ROI realization and a softening of organizational resistance.

2020-2021: Enterprise VR accelerates as ROI is demonstrated, and as organizational resistance breaks down due to acclimation and education.

2022: Software gains ground as it has faster refresh cycles through SaaS delivery, and as hardware becomes more embedded and mature in the enterprise.





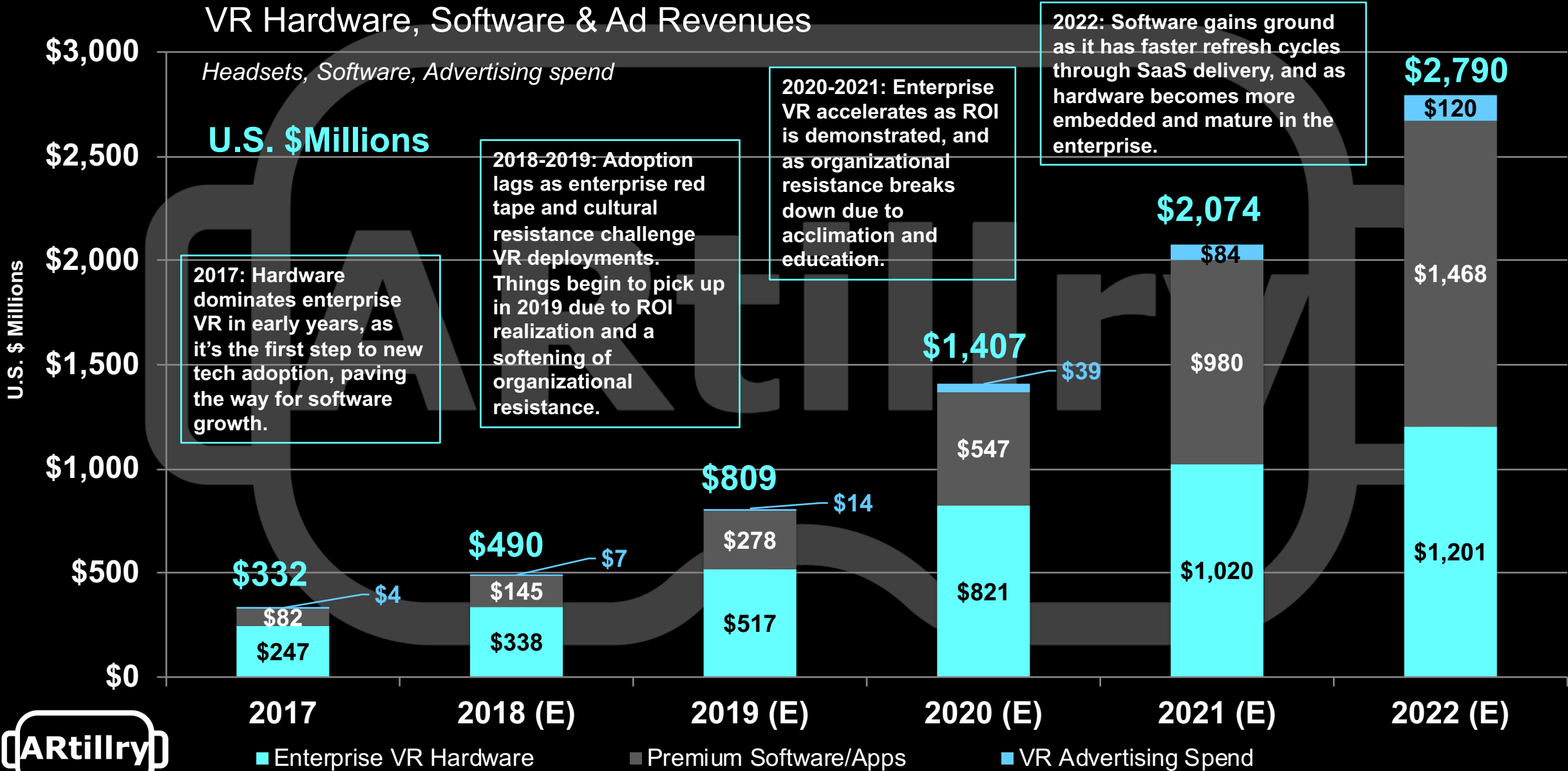
# ENTERPRISE VR DRILL DOWN

(DETAILED VIEW)

## VR Hardware, Software & Ad Revenues

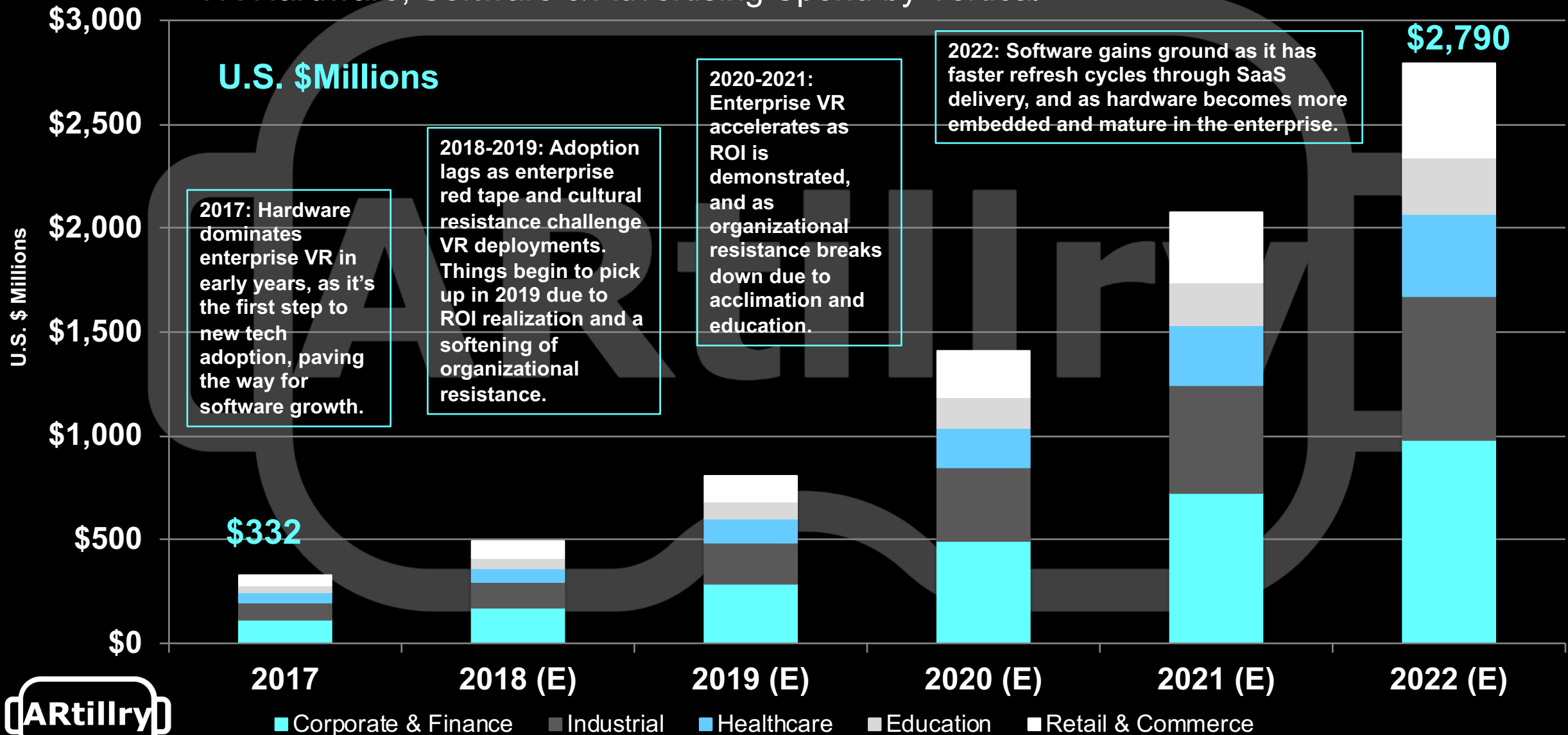
Headsets, Software, Advertising spend

U.S. \$Millions



# ENTERPRISE VR DRILL DOWN

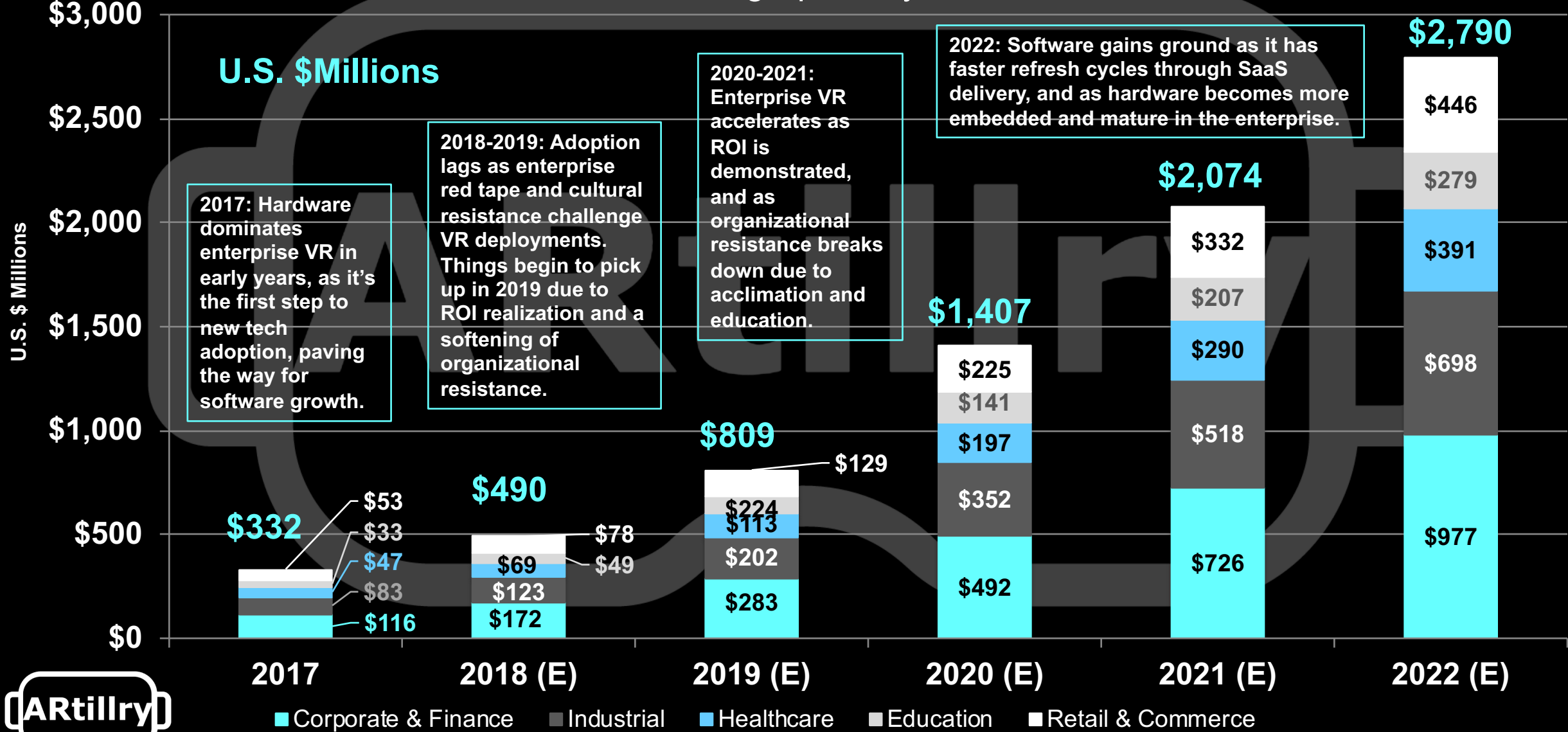
VR Hardware, Software & Advertising Spend by Vertical



# ENTERPRISE VR DRILL DOWN

(DETAILED VIEW)

VR Hardware, Software & Advertising Spend by Vertical




# VR DEVICE FORECAST



# VR HEADSET REVENUE

 **Global VR headset revenues will grow from U.S. \$1.83 billion in 2017 to U.S. \$5.04 billion in 2022, a 28% compound annual growth rate (CAGR).**

 **PSVR remains the market share leader for headset revenue, due to the Playstation 4 installed base (86M), though its share will recede over time.**


 **Oculus Go will grow at a fast pace and lead *unit share* by 2022, but its smaller price tag (\$199) inhibits its *revenue share* of VR headsets.**

 **Having the opposite effect, Vive Pro will have a low unit share but a high revenue share by 2022, given its high price tag and enterprise adoption.**

 **HTC Vive and Samsung Gear VR will perform relatively poorly versus competitors that have more flexibility to subsidize hardware (i.e. Oculus).**

 **Oculus – with the advantage of Facebook-backing and a revenue model detached from hardware sales – has this flexibility to apply loss-leader pricing in order to trade margins for market share.\***

 **This applies to its full line of headsets including Rift, Quest and Go.**

 \*See Artillry article: <https://artillry.co/2017/11/15/th-dynamics-of-aggressive-vr-pricing/>

# VR HEADSET REVENUE

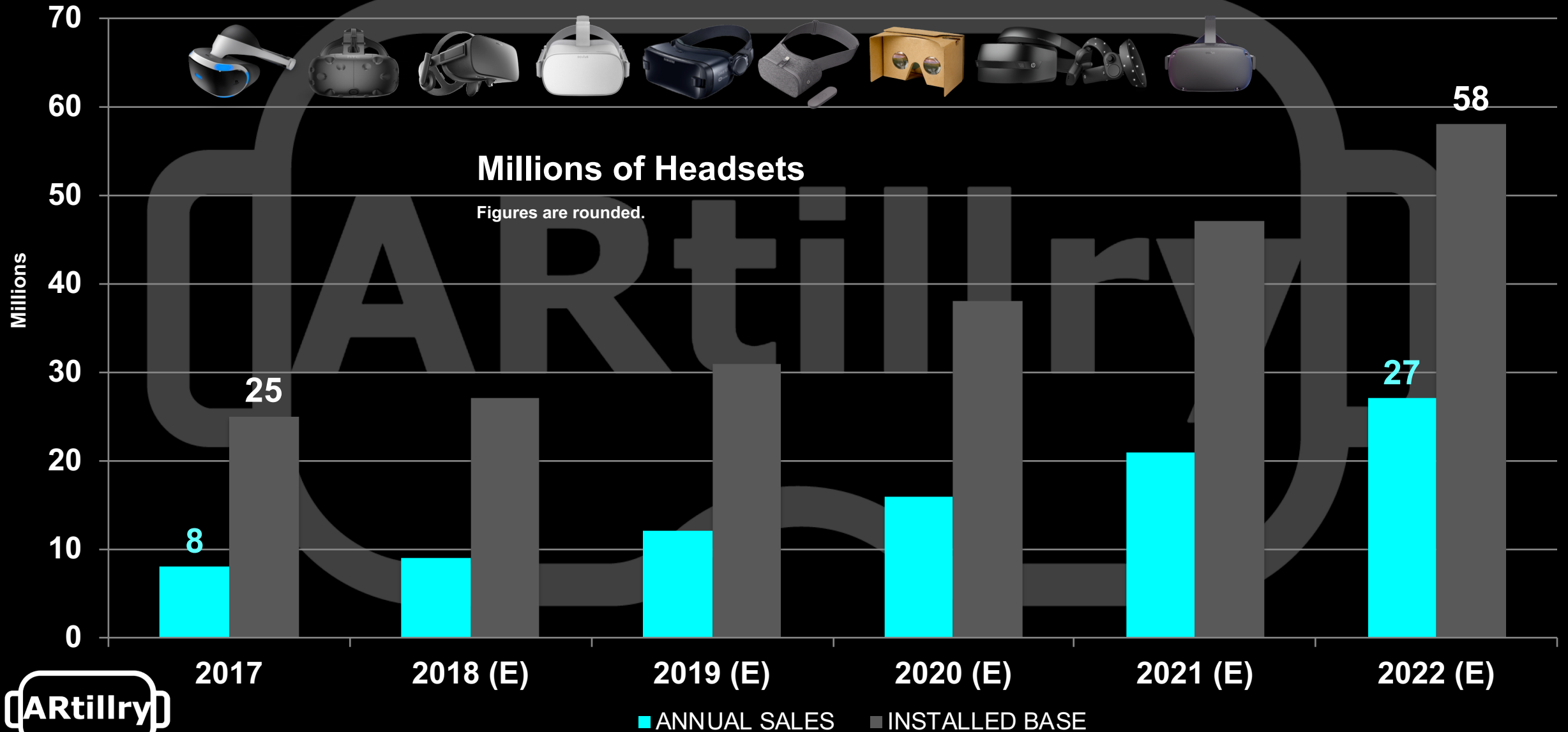
-  In units, the global VR headset market will grow from 9 million in 2017 annual sales to 29 million in 2022.
-  This correlates to a cumulative installed base of 26 million active VR headsets to 63 million units during the same period.
-  VR headset pricing will trend downward over the forecast period, from an average of \$468.50 in 2017 to \$286.89 in 2022.
-  Price competition will be a key adoption driver, bringing VR's entry point down to levels that are in the range of higher consumer demand.\*
-  Standalone headsets represent an effective “all-in” price for consumers, given that they don't require dedicated PCs, consoles or mobile devices.
-  Cardboard and other tier-4 devices are removed from average pricing calculations, as they're an outlier (as low as \$10 per unit).



\*See ARtillry Intelligence Briefing: [VR Usage & Consumer Attitudes](#) for original survey data on consumer pricing sentiments.

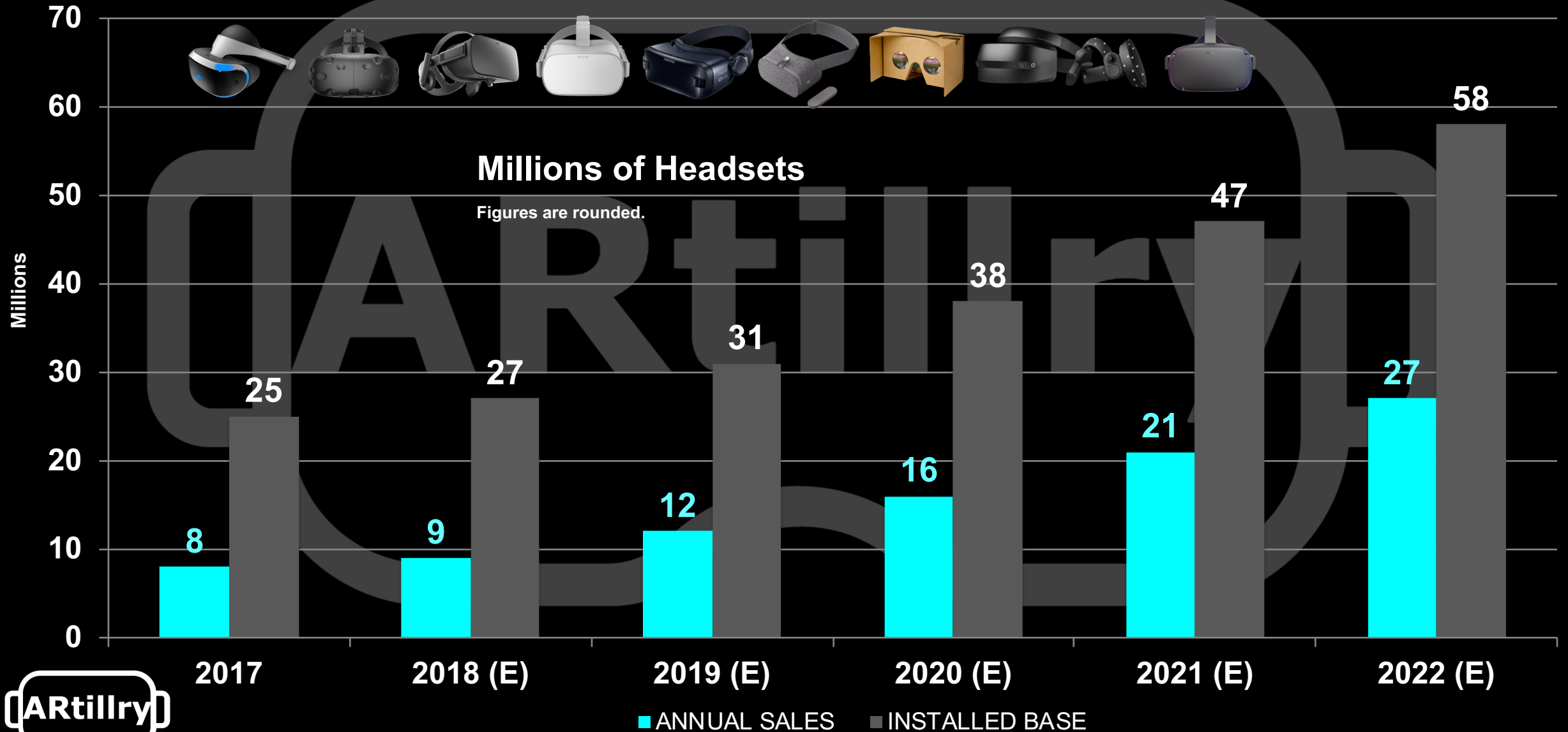
# GLOBAL VR HEADSET INSTALLED BASE

(SIMPLIFIED VIEW)



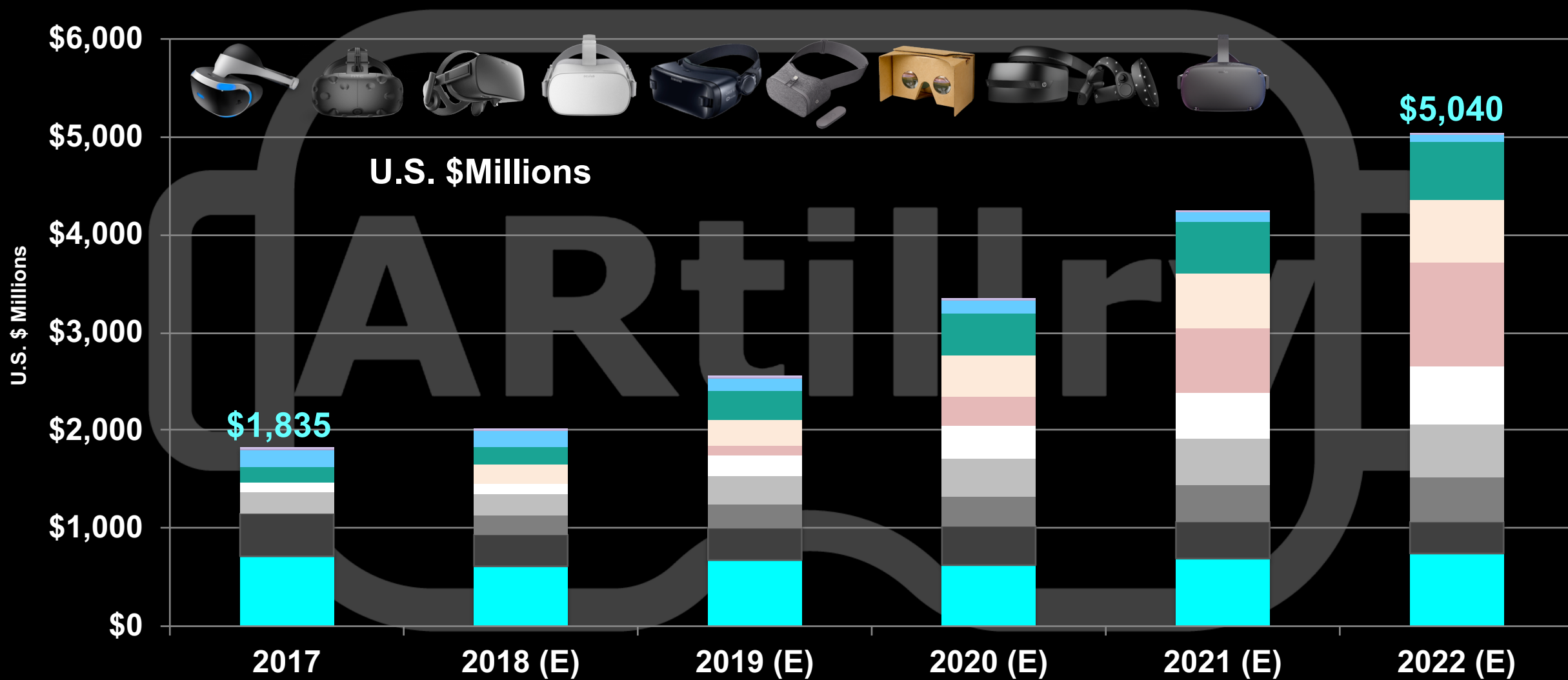
# GLOBAL VR HEADSET INSTALLED BASE

(DETAILED VIEW)



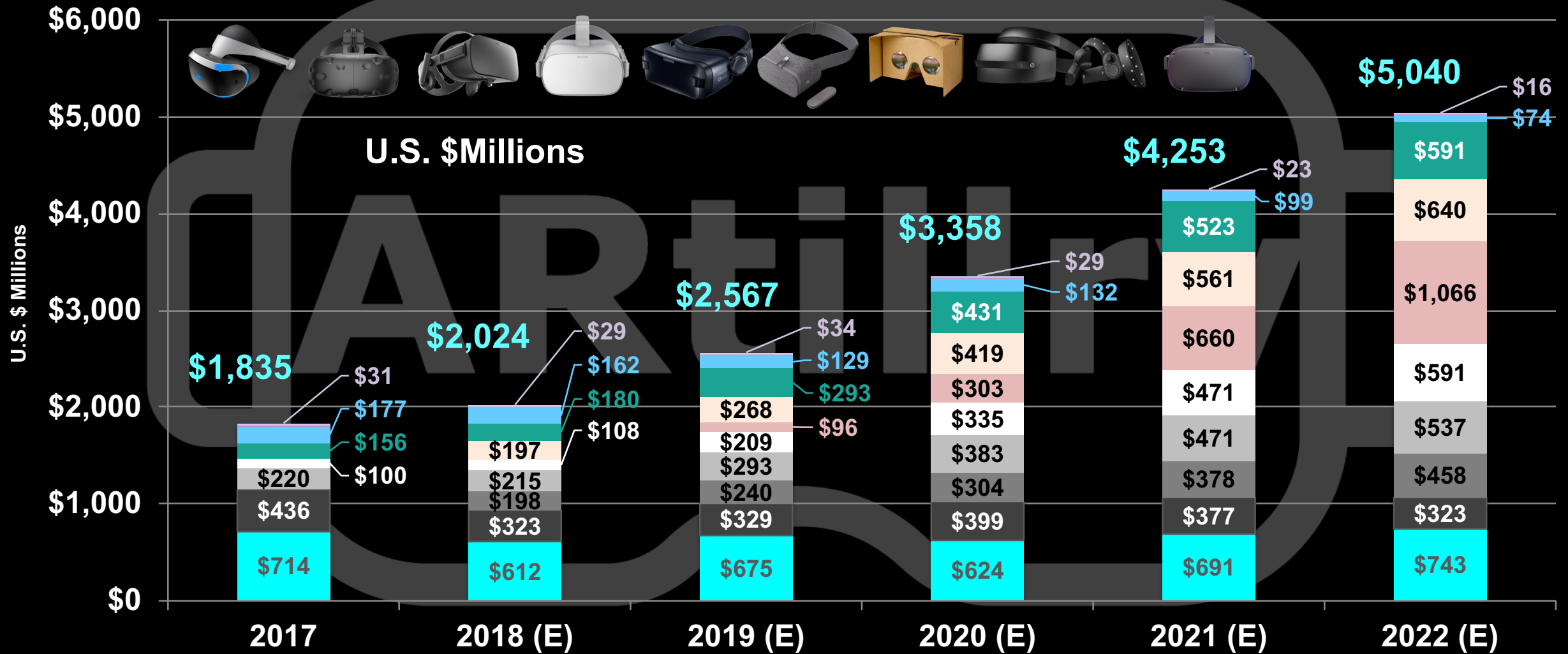


# GLOBAL VR HEADSET REVENUES



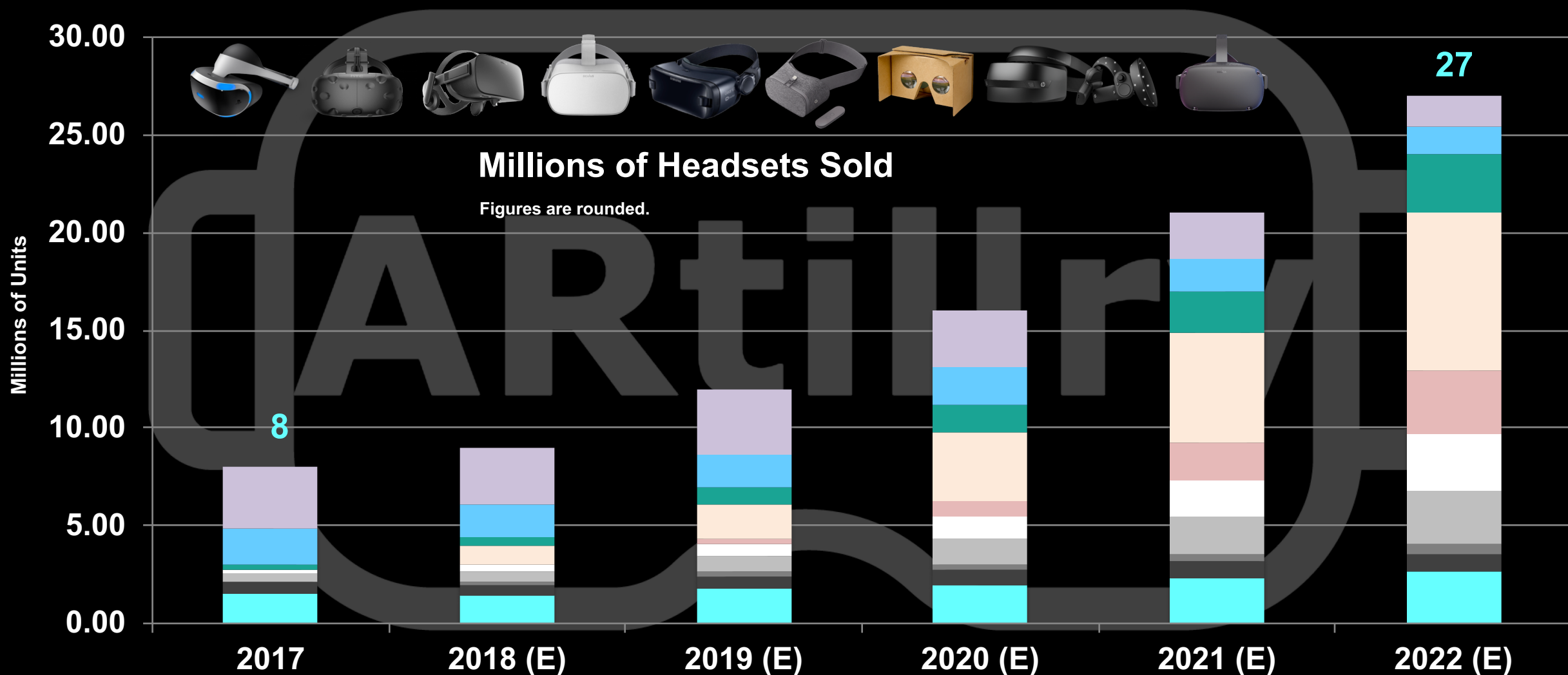
- PSVR
- WINDOWS MR & OTHER
- GEAR VR & OTHER TIER-3
- VIVE
- OCULUS QUEST
- CARDBOARD & OTHER TIER-4
- VIVE PRO
- OCULUS GO
- RIFT
- OTHER STANDALONE

# GLOBAL VR HEADSET REVENUES



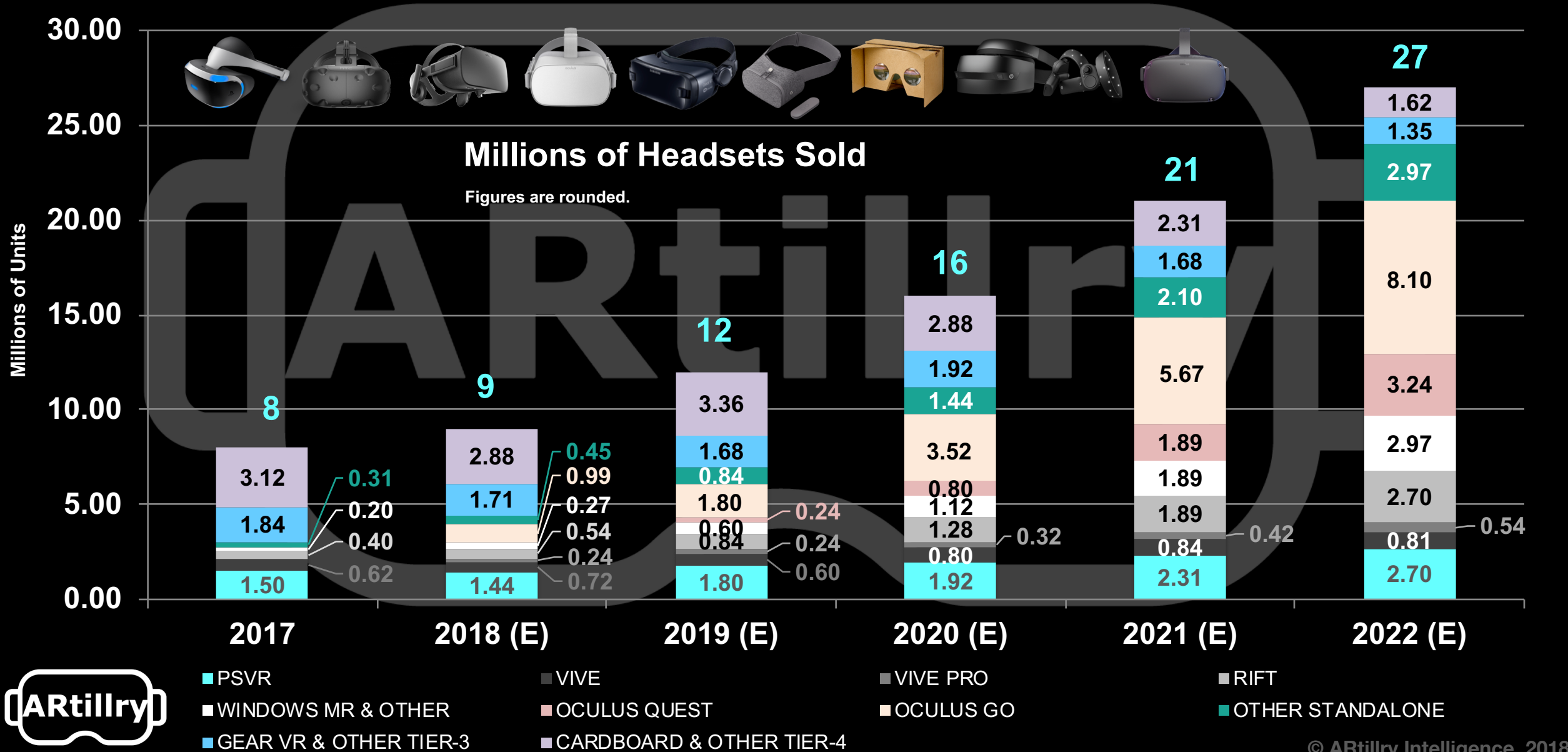
- PSVR
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- VIVE
- OCULUS QUEST
- CARDBOARD & OTHER TIER-4
- VIVE PRO
- OCULUS GO
- RIFT
- OTHER STANDALONE

# GLOBAL VR HEADSET UNIT SALES



- PSVR
- WINDOWS MR & OTHER
- GEAR VR & OTHER TIER-3
- VIVE
- OCULUS QUEST
- CARDBOARD & OTHER TIER-4
- VIVE PRO
- OCULUS GO
- RIFT
- OTHER STANDALONE

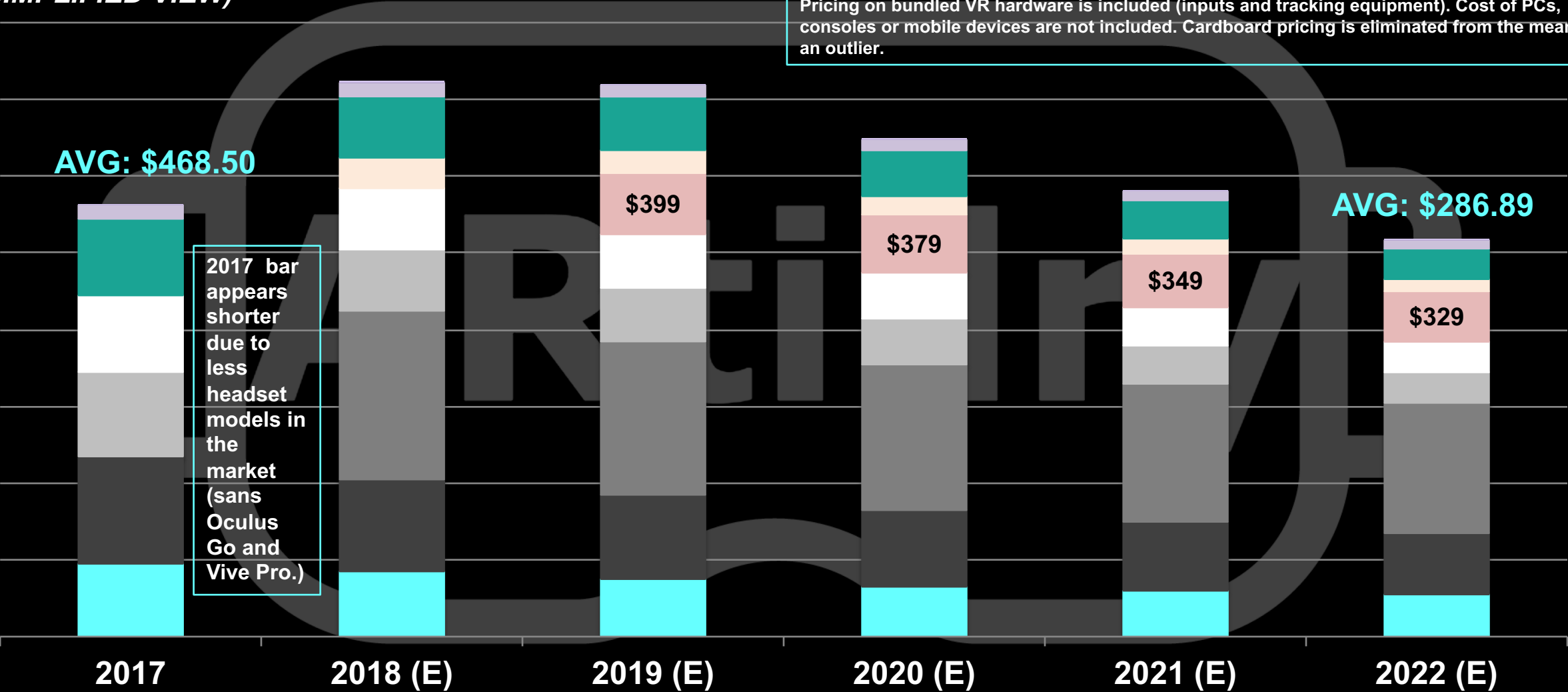
# GLOBAL VR HEADSET UNIT SALES



# GLOBAL VR HEADSET PRICING TREND

(SIMPLIFIED VIEW)

Headset prices are averaged within any given year, due to fluctuations throughout the year. Pricing on bundled VR hardware is included (inputs and tracking equipment). Cost of PCs, consoles or mobile devices are not included. Cardboard pricing is eliminated from the mean, as an outlier.

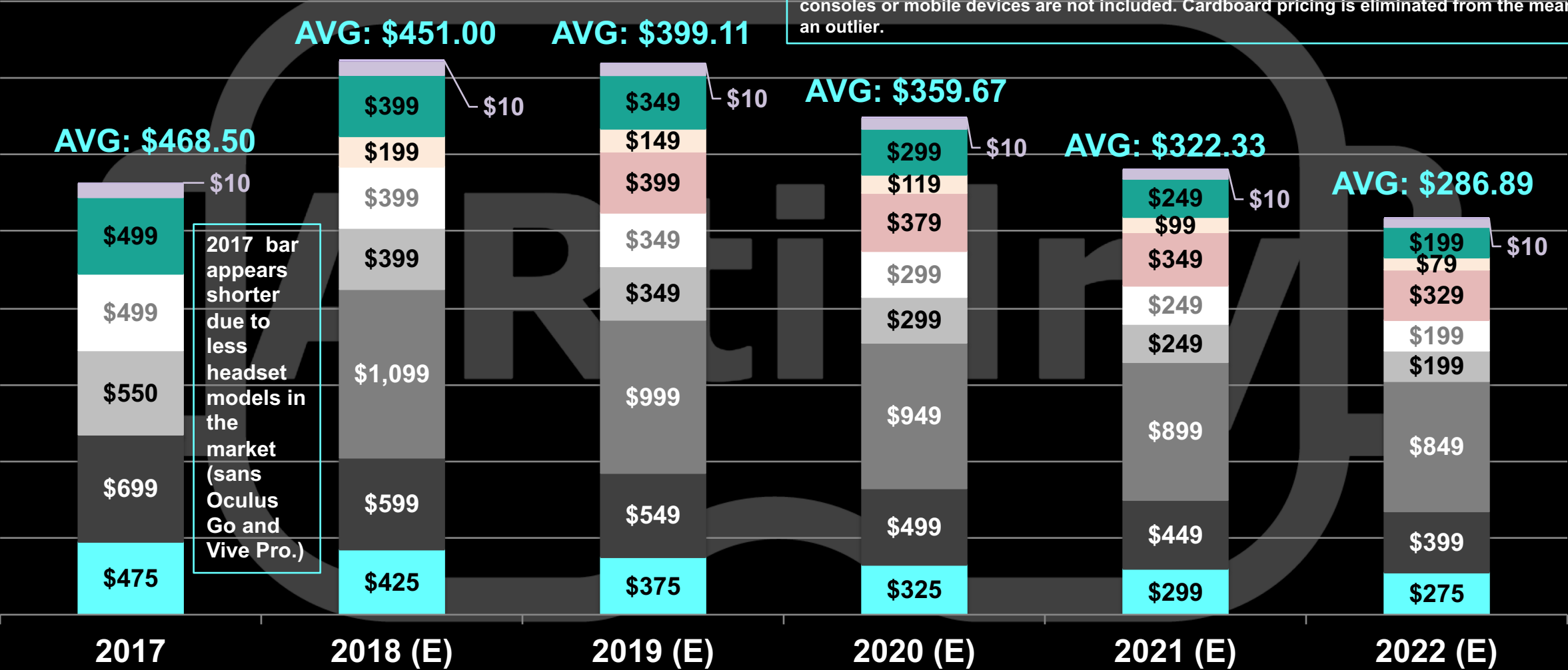


- PSVR
- WINDOWS MR & OTHER
- GEAR VR & OTHER TIER-3
- VIVE
- OCULUS QUEST
- CARDBOARD & OTHER TIER-4
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- RIFT
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# GLOBAL VR HEADSET PRICING TREND

(DETAILED VIEW)

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- PSVR
- VIVE
- VIVE PRO
- RIFT
- WINDOWS MR & OTHER
- OCULUS QUEST
- OCULUS GO
- OTHER STANDALONE
- GEAR VR & OTHER TIER-3
- CARDBOARD & OTHER TIER-4

# KEY TAKEAWAYS (REDUX)



# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Consumer AR** will grow from \$462 million in 2017 to \$16.5 billion in 2022, a 105 percent compound annual growth rate (CAGR). Near term revenues will be dominated by the mobile form factor. Revenues will also be software-centric during that time (mobile device sales aren't counted in this forecast) and will include premium apps and in-app purchases. The latter will dominate software revenues in the near term, due to consumer hesitance to pay upfront for AR apps, as well as the in-app revenue model validated by Pokémon Go. Niantic will find success in its Harry Potter-themed follow-up game to Pokémon Go, and its AR developer platform (AR as a Service) built on its architecture and game mechanics. These and other developing AR experiences will be built around in-app purchase models. A mobile AR killer app could emerge in 2019, likely built around a utility like Visual Search, or through viral growth of a native AR social/multiplayer app. Consumer AR revenues will begin to shift towards hardware starting in 2022 as smart glasses (possibly from Apple) finally reach tenable specs and standards for consumer markets. Software at that time will begin to shift to premium purchases (as opposed to in-app purchases) as it's a model conducive to dedicated AR hardware (similar to how apps/games are purchased in VR). Until then, development work in mobile AR apps will be a training ground for an eventual glasses-dominant era beyond 2022.



# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Enterprise AR** will grow from \$671 million in 2017 to \$28.5 billion in 2022, a 120 percent compound annual growth rate (CAGR). This makes it the largest XR sub-sector in 2022. Scale will result from wide applicability across enterprise verticals; and a form factor that supports all-day use and clear ROI (e.g. manufacturing efficiencies). Adoption is currently dampened by typical organizational inertia, enterprise risk aversion and sales cycles. ARtillery Intelligence believes these factors will continue to stunt enterprise AR growth but will be outweighed eventually by the momentum, support and ROI realizations that are currently building. A tipping point will come in 2020, after which adoption accelerates in a sort of enterprise herd mentality. This will follow a similar pattern, though on a smaller scale, as enterprise smartphone adoption over the past decade and is further supported by survey-validated enterprise AR pilot projects active today. Near-term Enterprise AR revenues will be hardware-dominant as it's the first step in enterprise tech adoption. Hardware growth creates an installed base for software, which will dominate enterprise AR in outer years. Enterprise hardware will also mature as it's established in the enterprise, with replacement cycles outpaced by software refresh rates, likely packaged and sold in a SaaS manner. AR advertising spend by enterprises is included in these figures and segmented in this report.

# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Consumer VR** will grow from \$2.4 billion in 2017 to \$8.6 billion in 2022, a 29 percent compound annual growth rate (CAGR). Like enterprise VR, it will be hardware-dominant in early years as its installed base is established. Over time, software (in this case, games and apps) will eclipse hardware revenues with a faster refresh cycle. A greater installed base of hardware will also incentivize VR content creators to invest in long-form content, resulting in more robust VR content libraries and greater software spending per user (ARPU). Premium apps will dominate software revenues but in-app purchases will also contribute, especially in gaming. Installed software and apps will also dominate, but slowly give way to web VR as its capability evolves. Price competition among VR headset manufacturers (e.g. Oculus, Sony, Samsung) will accelerate consumer adoption. Oculus Go, at a \$199 price point, hits a sweet spot for content availability, quality and affordability, and we project it to reach unit sales of 990 thousand this year. Oculus – with the advantage of Facebook-backing – has the flexibility to apply loss-leader pricing in order to trade margins for market share. That will give it a strong competitive position versus players that are dependent on hardware revenue (i.e. HTC, Samsung). Given a gift-able price point, the 2018 holiday quarter will be a “moment of truth” for Oculus Go. The untethered higher-end Oculus Quest will see similar pricing and content advantages when it launches in Q2 2019.

# KEY TAKEAWAYS

Takeaways and growth dynamics for XR and its sub-sectors.

**Enterprise VR** will grow from \$332 million in 2017 to \$2.8 billion in 2022, a 53 percent compound annual growth rate (CAGR). Though strong in its own right, it will hold the smallest share of XR revenues among the sub-sectors measured in this forecast. VR will be stronger as a consumer play (see previous slide), while AR is stronger in the enterprise. These VR shortcomings (relatively speaking) in the enterprise stem from the medium's inherent isolation, which inhibits some job functions and share of time per working day. This is especially true in industrial functions where "heads up" awareness is inherent, and where AR will conversely shine. VR will add more value in corporate and finance settings, such as employee training and data visualization among others (vertical spending breakdown provided in this report). Like AR, VR's near-term enterprise revenue will be hardware-dominant as it's the first step to tech adoption. That installed base will pave the way for enterprise VR software revenues to grow and overtake enterprise VR hardware revenues by 2022. Unlike AR, which will have specialized hardware that's optimized for enterprise functions, VR will utilize common hardware (the same hardware used in consumer contexts). The availability, evolution and economics of that increasingly penetrated hardware will be an adoption accelerant, and an advantage for enterprise VR.



# NEXT STEPS, REFERENCE & METHODOLOGY



# NEXT STEPS

In addition to standalone status, this forecast lays the groundwork for *ARtillry Intelligence* future deliverables.

With the foundation of this data set, several subsequent narratives will be developed in the coming months that each drill down into XR sub-sectors, rationale, revenue-drivers and strategic implications.

We will also update this data set bi-annually, projecting a five-year time horizon with each forecast. We will expand the scope of this forecast over time as well, to include more categories of AR & VR spending (see slide 5 for exclusions).

We encourage questions and coverage suggestions at <https://artillry.co/contact/>



# ABOUT ARTILLRY INTELLIGENCE

ARtillry is a publication and intelligence firm that examines augmented reality (AR) and virtual reality (VR). Through writings, data and multimedia, it provides deep and analytical views into the industry's biggest players and opportunities. It's about insights, not cheerleading.

Run by career analyst and journalist Mike Boland, coverage is grounded in a disciplined and journalistic approach. It also maintains a business angle: Though fun and games permeate VR and AR (especially the former) long-term cultural, technological and financial implications are primary.

Learn more at <https://artillry.co/about/>





# ABOUT INTELLIGENCE BRIEFINGS

*ARtillry Intelligence Briefings* are monthly installments of VR/AR data and analysis. They synthesize original and third-party data to reveal the dynamics of VR and AR sectors, and their opportunities.

In addition to data, a layer of insights is applied to translate market events and raw figures into prescriptive advice. This takes form in a narrative story arc, grounded in market figures.

Questions and requests for deeper analysis can be submitted at: <https://artillry.co/contact/>



# ABOUT THE AUTHOR

Mike Boland was one of Silicon Valley's first tech reporters of the Internet age, as a staff reporter for *Forbes* (print) starting in 2000. He has been an industry analyst covering mobile and social media since 2005, and is now Chief Analyst of *ARtillry Intelligence*, covering emerging tech.

Mike is a frequent speaker at industry conferences such as VRLA, ad:tech and LeadsCon. He has authored in-depth reports and market-sizing forecasts on the changing tech & media landscape. He contributes regularly to highly read online news sources such as *TechCrunch*, *Business Insider* and the *Huffington Post*.

A trusted source for tech journalists, his comments have appeared in A-list publications, including *The New Yorker*, *The Wall Street Journal* and *The New York Times*.

Further background, history and credentials can be found at <http://www.mikebo.land/>

# METHODOLOGY

*ARtillery Intelligence* follows disciplined best practices in market sizing and forecasting, developed and reinforced through its principles' 15 years in research and intelligence in the tech sector. This includes the past 2.5 years covering AR & VR as a main focus.

This report focuses on AR and VR revenue projections in various sub-sectors and product areas. *ARtillery Intelligence* has built financial models that are customized to the specific dynamics and unit economics of each. These include variables like unit sales, company revenues, pricing trends, market trajectory and several other micro and macro factors that *ARtillery Intelligence* tracks.

This approach primarily applies a *bottom-up* forecasting methodology, which is secondarily vetted against a top-down analysis. Together, confidence is achieved through triangulating revenues and projections in a disciplined way. For more information on what's included and not included in the forecast (a key consideration when evaluating the figures) see slide 5.

More about *ARtillery Intelligence*'s market-sizing credentials can be found at <http://www.mikebo.land/forecasting>

# DISCLOSURE AND ETHICS POLICY

*ARtillery* has no financial stake in the companies mentioned in this report, nor received payment for its production. With respect to market sizing, *ARtillery* remains independent of players and practitioners in the sectors it covers. It doesn't perform paid services or consulting for such companies, thus mitigating bias — real or perceived — in market sizing and industry revenue projections.

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